DELAWARE RIVER BASIN
POND CREEK, MONROE COUNTY

PENNSYLVANIA

MARSHALL LAKE DAM

NDI ID NO. PA-00985
DER ID NO. 45-52

RICHARD C. MacDONOUGH

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared by
Geo-Technical Services, Inc.
CONSULTING ENGINEERS & GEOLOGISTS
851 S. 19th Street
Harrisburg, Pennsylvania 17104

"Original copy [illegible] plates: All DTIC reproductions will be in black and white"

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JULY 1981

DELAWARE RIVER BASIN

POND CREEK, MONROE COUNTY

PENNSYLVANIA

MARSHALL LAKE DAM

NDI ID NO. PA-00985
DER ID NO. 45-52

RICHARD C. MACDONOUGH

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DACW31-81-C-0019

Prepared by

GEO-Technical Services, Inc.
Consulting Engineers & Geologists
851 S. 19th Street
Harrisburg, Pennsylvania 17104

For

Department of the Army
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

July 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Marshall Lake Dam NDI ID No. PA-00985 DER ID No. 45-52
Size:	Small (8.9 feet high, 62 acre-feet)
Hazard Classification:	High
Owner:	Richard C. MacDonough Marshalls Creek, PA. 18335
State Located:	Pennsylvania
County Located:	Monroe
Stream:	Pond Creek
Date of Inspection:	November 11, 1980

Based on visual inspection, Marshall Lake Dam is judged to be in poor condition. Based on the location of the downstream dwellings and the fact that more than a few lives could be lost should the dam fail, the dam is classified as a high hazard structure. The criteria established for these studies require that the dam pass a Spillway Design Flood (SDF) of between a 1/2 Probable Maximum Flood (1/2 PMF) and the full PMF. Based on the small size and storage capacity of the facility, it is judged that the SDF of 1/2 PMF is appropriate for the Marshall Lake Dam. Under the present conditions, the spillway will pass approximately 4 percent of the PMF without overtopping the dam. As the spillway cannot pass the 1/2 PMF without overtopping the dam, and since overtopping at less than 1/2 PMF would cause failure which would significantly increase hazard to loss of life downstream, the spillway is seriously inadequate and the facility is rated unsafe, non-emergency.

The condition of the outlet works could not be inspected as it was submerged. Ready access to an operable gate, or other method of drawing down the reservoir during emergencies, is required.

There is no emergency warning system, or a plan to evacuate downstream population, should hazardous conditions develop at the dam.

Maintenance of the dam is limited to the left end of the embankment, between the left abutment and the outlet works.

The following investigation and remedial measures are recommended for immediate implementation by the owner. All investigations and design of remedial measures should be performed under the direction of a Professional Engineer, experienced in the design and construction of dams.

(1) Perform additional hydrologic and hydraulic analyses to more accurately determine the required spillway capacity for the Marshall Lake Dam. Design and construct a spillway that will pass the required SDF without overtopping the dam.

(2) Remove the trees from the embankment and the sandbar from the spillway channel.

(3) Locate and operate the submerged outlet works gate, or provide other emergency means of drawing down the reservoir. If the gate is operable, observe the conditions at the toe when the outlet works are subject to pressure flow. Take appropriate action as necessary.

In addition, it is recommended that the owner take the following precautionary operational and maintenance measures:

(1) Develop a detailed emergency operation procedure and warning system to facilitate timely and orderly evacuation of the downstream population if any hazardous conditions at the dam are observed.

(2) When warnings of a storm of major proportions are given by the National Weather Service, activate the emergency operation and warning system procedures.

(3) After satisfactory implementation of the remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a

MARSHALL LAKE DAM

Professional Engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

Submitted by:

GEO-TECHNICAL SERVICES, INC.

Gideon Yachin

GIDEON YACHIN, P.E.

Date: July 10, 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS

JAMES W. PECK, COLONEL
CORPS OF ENGINEERS
COMMANDER AND DISTRICT ENGINEER

Date: 3 August 81

MARSHALL LAKE DAM (PA-00985)

(SPILLWAY ON LEFT & MARSHALL CREEK IN FOREGROUND)

OVERVIEW

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

MARSHALL LAKE DAM

NDI# PA-00985, PENNDER# 45-52

SECTION 1
GENERAL INFORMATION

1.1 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.2 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.3 Description of Project.

a. Dam and Appurtenances: Marshall Lake Dam is an earthfill embankment approximately 9 feet high and 305 feet long, including spillway. The spillway is located at the right abutment, consisting of an 80 foot long and 1.5 foot wide concrete weir. The weir intersects the slope of the right abutment and terminates at a vertical concrete endwall on the earthfill dam embankment. The outlet works consist of a 24-inch diameter steel pipe with no visible upstream or downstream controls.

b. Location: Marshall Lake Dam is located on Pond Creek in Smithfield Township, Monroe County, 300 feet northeast of the intersection of State Route 402 with U.S. (business) Route 209, within the community of Marshalls Creek, Pennsylvania. The dam and reservoir are contained within the East Stroudsburg and Bushkill, Pennsylvania 7.5 minute series USGS Quadrangle maps, at Latitude N41 02'35" and Longitude W75 07'38". A Location Map is shown in Exhibit E-1.

c. Size Classification: Small (8.9 feet high, 62-acre feet storage capacity at top of dam).

d. Hazard Classification: High (see paragraph 3.1e).

e. Ownership: Richard C. MacDonough, Marshalls Creek, Pennsylvania 18335.

f. Purpose of Dam: The original purpose of the impounded water was for ice harvesting. Presently, the lake is used for recreation.

g. Design and Construction History: Information related to the design and construction of the dam is not available. Data obtained from the Pennsylvania Department of Environmental Resources (PENNDER) indicate that the dam was constructed around 1904 to 1909. Although "as-built" drawings are not available, inspection reports, correspondence and photographs document the condition of the dam since 1919. This information is on file with PENNDER.

h. Normal Operational Procedure: The pool is maintained at the spillway crest elevation with excess inflow discharging over the spillway into Pond Creek. The existing outlet works is presently inoperable.

1.4 Pertinent Data.

a. Drainage Area: (square miles)	7.88
b. Discharge at Damsite: (cfs)	
Maximum known flood at damsite since construction	Not Known
Outlet works at maximum pool elevation (Presently inoperative)	Not Applicable
Spillway capacity at maximum pool elevation	
Design Conditions	Not Known
Existing Conditions	560
c. Elevation: (feet above msl) See paragraph 3.1a for datum.	
Top of Dam	
Design Conditions	Not Known
Existing Conditions (Lowest point)	471.8
Maximum Pool	
Design Conditions	Not Known
Existing Conditions	471.8
Normal pool (spillway crest)	470.2
Upstream invert outlet works	Not Known
Downstream invert outlet works	462.9
Streambed at toe of dam	462.9
d. Reservoir Length: (feet)	
Normal Pool	3700
Maximum Pool (at top of dam)	3800
e. Storage: (acre feet)	
Normal Pool	40
Maximum Pool	
Design Conditions	Not Known
Existing Conditions	62
f. Reservoir Surface: (acres)	
Normal Pool	11
Maximum Pool	
Design Conditions	Not Known
Existing Conditions	12

g. Dam:

Type - Earth Fill Embankment	
Length (feet) (excluding spillway)	225
Height (feet)	8.9
Top Width (feet)	
Design Conditions	Not Known
Existing Conditions - (varies from 9' at left abutment to 14' at the right abutment).	
Side slopes - (Upstream vary; steepest slope 1V:2.2H. Downstream vary from 1V:2H (left abutment) to 1V:3.1H near the right abutment).	
Zoning	Not Known
Cut-off	Not Known
Impervious Core	Not Known
Grout Curtain	Not Known

h. Diversion and Regulating Tunnel: None

i. Spillway:

Type - Broad crested weir, having a trapezoidal cross sectional area.	
Length of Weir (feet)	80
Upstream Channel - Adverse sloping earthen channel into the reservoir.	
Downstream Channel - Riprapped apron followed by an earthen channel, paralleling the toe of the dam to streambed.	

j. Outlet Works:

Type - 24 inch diameter steel pipe with upstream control.	
Length (feet)	35 (approximately)
Closure and Regulating Facilities - A wooden gate (reported by owner). No hoisting device is visible.	
Access	Assumed to be by diving

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available: There is no available information related to the design and construction of the dam. The earliest information available consists of a 1919 report, accompanied with a sketch and photographs, prepared by the Water Supply Commission of Pennsylvania. Inspection Reports accompanied with photographs depict the condition of the dam in 1920 and 1966 and are on file with PENNDER.

b. Design Features:

(1) Dam: The dam is an earthfill embankment with varied upstream and downstream seeded slopes. The steepest upstream slope is 1 Vertical on 2.2 Horizontal (1V:2.2H). The downstream slope varies from 1V:2H on the left abutment to 1V:3.1H near the right abutment. The total length of the earth embankment is 225 feet and the width of its crest varies from 9 feet at the left abutment to 14 feet at the right abutment. The maximum height of the embankment is 8.9 feet.

(2) Appurtenant Structures:

(a) Spillway: The spillway is an 80-foot long and 1.5 foot wide concrete weir, located on the right abutment. A 24-foot long vertical concrete endwall retains the earth embankment at the junction with the left end of the spillway. The endwall is 2.8 feet high at the spillway crest and 2 feet thick at the bottom, narrowing to approximately one foot wide at the top of the earth embankment. The right end of the spillway terminates at the natural bank of the right abutment, forming a trapezoidal cross sectional area. Upstream of the concrete weir the earth lined spillway bottom slopes downward into the reservoir, forming a short approach channel with an adverse slope. Immediately downstream of the weir the spillway channel bottom is flush with the top of the concrete weir, sloping 15% in a downstream direction, perpendicular to the weir, along a distance of 30 feet. The first 10 feet of the spillway channel, adjacent to the concrete weir, is lined with concrete grouted riprap for a total width of 80 feet. Approximately 30 feet downstream of the concrete weir the spillway channel narrows from 80 feet to a 20 foot wide outlet channel, bends sharply to the left and following in a southwesterly direction, paralleling the toe of the dam, to the streambed of Pond Creek.

(b) Outlet Works: The outlet works, consisting originally of a square culvert with an upstream control, is located at the maximum section of the dam near the left abutment. The present visible outlet at the toe of the dam is a 24-inch diameter steel pipe, terminating with a vertical concrete endwall (see Exhibit A-3, Appendix A).

(c) Ice House and Chute: Between 1904 and 1920, an ice house was located on the right abutment, immediately to the right of the spillway. A wooden chute across the spillway was used to facilitate storing and loading ice blocks (see Exhibit E-2, Appendix E).

2.2 Construction Records.

There are no records available for evaluation of construction methods and the classification or quality of materials placed in the dam.

2.3 Operation.

There are no records available to indicate the past operation procedures for the dam. The present normal operation of the facility is described in paragraph 1.3h, Section 1.

2.4 Other Investigations.

Available information indicates that on-site inspections were made in April 1919, June 1920 and April 1966. Deficiencies observed in 1919 indicated that the top of the embankment was irregular and contained several low points on the crest of the dam, the lowest of which was only one foot higher than the spillway crest. The dam was also found "badly in need of repair". On June 3, 1919, the previous owners of the dam (R.D. Hoffman & Sons) were notified by the Pennsylvania Water Supply Commission of the deficiencies observed in the dam, as quoted below:

"The spillway is inadequate to discharge maximum floods, the right abutment is not in satisfactory condition, the embankment is irregular and lower in places than the top of the spillway abutments. The Commission, therefore, directs that the dam be repaired and strengthened in a substantial manner by increasing the capacity of the spillway to provide for a flow of 2,000 cubic feet per second (it now has a capacity of about 925 second-feet); confining the spillway by substantial abutments and by raising the embankment to the top of the abutments and providing a 1 on 2 slope downstream."

2.5 Evaluation.

a. Availability of Data: Engineering data were extracted from the files of PENNDER. The owner stated that he has no plans of the dam nor information related to its construction.

b. Adequacy: In the absence of plans, engineering specifications and construction records, assessment of the structural integrity of the dam and its safety must be based on the combination of available cited data, visual inspection, performance history, as well as the hydrologic and hydraulic analysis (see Section 5).

c. Validity: There is no reason to question the validity of the available data.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General: The overall appearance of the dam and spillway is poor. Deficiencies observed during the field inspection are noted on the General Plan, Exhibit A-1 and are described in the subsequent paragraphs. The profile and typical sections of the dam are presented in Exhibits A-2 and A-3 and are based on field survey made on the day of the inspection. The survey datum for this inspection is elevation 469 above mean sea level, a disc in the wingwall of State RTE 402 bridge over Pond Creek. On the inspection date (11/25/1980), the lake level was 0.1 foot above the spillway crest. Visible features of the dam and appurtenant structures are depicted in photographs presented in Appendix C.

b. Embankment: Observations made during the field inspection reveal a heavy growth of trees and brush on top of the dam, on the downstream slope and at the toe of the dam (see photographs 1,2,4 and 6, Appendix C). The crest width varies from 9 feet at the left abutment to 14 feet near the spillway endwall on the right abutment. The top of dam elevations vary as indicated in Exhibit A-2. The lowest top of dam elevation is 471.8, which is 1.6 feet higher than the spillway crest and is located near the left abutment. The top of dam elevation on the right abutment, at the junction between the embankment and spillway endwall, is 472.1, which is 0.9 foot lower than the top of the left spillway endwall. The upstream slope of the embankment above the lake level is covered by vegetation, with no visible erosion (see Photograph 1, Appendix C). The upstream slope varies, with the steepest slope being 1V:2.2H. The downstream slope varies from 1V:2H at the left abutment to 1V:3.1H at the right abutment. There was no visible seepage at the toe of the embankment or leakage through or around the spillway and outlet works endwalls.

c. Appurtenant Structures:

1. Spillway: The spillway design features are described in paragraph 2.1b.(2)(a). The appearance of the spillway is very poor, as illustrated in photographs 2, 8 and 9, Appendix C. A sand bar near the left end of the spillway forms an oblong shaped island, resulting in divided flow within the spillway outlet channel (see photographs 8 and 9, Appensix C). Approximately 30 feet downstream of the 80 foot long concrete weir, the spillway outlet channel bends sharply to the left and narrows from an 80 foot wide channel to a 20-foot-wide channel.

There was no evidence of bank erosion in the spillway outlet channel throughout its entire alignment. A small pear-shaped island is located near the junction of the spillway outlet channel and Pond Creek, downstream of the dam (see Exhibit A-1 and Photographs 4 and 5, Appendix C).

2. Outlet Works: The outlet works design features are described in paragraph 2.1b.(2)(b). The outlet of the 24-inch diameter steel pipe was submerged on the day of the inspection (see Outlet Works Section, Exhibit A-3 and Photograph 6, Appendix C). The concrete endwall terminal structure appears to be in good condition. There was no visible hoisting mechanism nor means of access to the reported upstream wooden gate at the inlet to the 24-inch diameter pipe.

d. Reservoir Area: The Pond Creek watershed is predominantly wooded, rising from elevation 720 to elevation 1,120 along Big Ridge, 3.5 miles northeast of the dam. Pond Creek is flowing in a southwesterly direction just north of U.S. RTE 209 and adjacent to the southern limits of the drainage divide. The creek is characterized by flat slopes and narrow flood plain, as indicated by the oblong shapes of Marshall Lake and the Rakes Dam Reservoir, located one mile upstream of the Marshall Lake Dam. Marshall Lake narrows from an approximate width of 250 feet, within the first 1100 feet upstream of the dam, to a 40-foot wide stretch, terminating at the first road intersection with U.S. RTE 209 and approximately 3700 feet upstream of the dam. A small masonry dam (6-feet-high) with a 15-foot long spillway is located immediately upstream of the road intersection (see Exhibit E-1). On the day of the inspection, the head over the spillway was 0.3 foot with a free overflow into the inlet of Marshall Lake. Inflow into Marshall Lake is affected by existing impoundments and swamps upstream of Rakes Dam (NDI No. PA-00993; DER ID No. 45-148). Development around the lake is limited to a few residences along the lake shore. Seasonal resort areas are located some 300 feet north of the right shoreline; as shown in Exhibit E-1, Appendix E. The slope along the right shoreline varies from 20% to 32% at the right abutment. The toe of an abandoned railroad grade forms the left shoreline of the lake (see Exhibit A-1, Appendix A). The southern drainage divide parallels the railroad grade, at a distance of approximately 500 feet south of the lake shore. The slope between the drainage divide and the railroad grade is generally mild with occasionally steeper slopes south of U.S. RTE 209. The impoundment of the small masonry dam at the inlet of Marshall Lake serves as a sediment trap, as evidenced by the small sandbar island upstream of the lake inlet. There is no evidence of slides or slope creep around Marshall Lake that can affect the safety of the dam. Pertinent geologic features are presented in Exhibit F, Appendix F.

e. Downstream Channel: Immediately downstream of the dam, the left bank of Pond Creek consists of an abandoned railroad grade with near vertical stone wall protection (see Photograph 5, Appendix C). The railroad grade is presently serving as a private drive with an access to State RTE 402, immediately south of the bridge abutment (see Exhibit A-1 and Photograph 10, Appendix C). On the inspection date, the water surface in Pond Creek was approximately one-foot below the top of its right bank. The flood plain of Pond Creek, between the dam and State RTE 402, is 150 feet wide, extending from the right bank of the creek to the drainage divide and is a well maintained meadow (see Exhibit A-1 and Photograph 10 and 11, Appendix C).

Two 2-story frame houses are located in the flood plain approximately 230 feet below the dam (see Photograph 11, Appensix C). The lowest first floor elevation of these homes is 4 feet above the streambed. A red brick building, housing a General Store and a bar, is located on the left bank of the creek, immediately downstream of State RTE 402 (see Photograph 10, Appendix C). The wall adjacent to the creek forms a vertical left bank.

The top of the right bank, opposite the General Store, is 3 feet above the streambed; whereas the floor level of the bar is 5 feet above streambed. Downstream of the General Store, the top of the left bank is 5 feet above streambed. The flood plain on the left bank is rising gently one foot along a 100-foot distance perpendicular to the stream to US Business RTE 209, beyond which the flood plain of Pond Creek coincides with the flood plain of Marshall Creek, downstream of the confluence of both creeks. A total of four residences and eight business establishments, including a post office, are located between the toe of Marshall Lake Dam and the confluence of Pond Creek with Marshall Creek, 1000 feet downstream of the dam. The survey of downstream conditions indicates that more than a few lives can be lost and significant property damage incurred should the dam fail when the cited structures are occupied. Consequently, Marshall Lake Dam is classified as a high hazard structure.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The reservoir is maintained at normal pool level with the excess inflow discharging over the spillway into the downstream channel. The upstream control for the outlet pipe was not visible and does not appear operational.

4.2 Maintenance of Dam.

Maintenance activities by the present owner appear to be limited to the mowing of grass on the portion of the embankment adjacent to the left abutment (see Photographs 1, 5 and 6, Appendix C). Large trees on top of the dam and on its downstream slope, as well as trees and brush in the spillway outlet channel, were noted in the 1966 inspection report. Since removal of the large trees from the dam proper was considered to be detrimental to the safety of the dam, the present owner of the dam was instructed on 9/16/1966 to remove trees and brush from the spillway (wasteway) channel. The condition of the spillway channel on 11/25/80 are shown in Photographs 2, 8 and 9, Appendix C. The condition of the earth embankment is illustrated in photographs 1, 4, 5 and 6, Appendix C.

4.3 Maintenance of Operating Facilities.

The condition of the upstream operating facilities for the outlet pipe could not be verified during the site inspection. Previous reports indicate the existence of a wooden gate at the intake of the outlet works. The present owner has had no occasion to operate the gate.

4.4 Warning System in Effect.

There is no emergency operation and warning system in effect at the present time.

4.5 Evaluation.

The present maintenance of the dam and appurtenant structures is inadequate. Upon the removal of all trees and brush from the earth embankment and the debris in the spillway outlet channel, the owner should institute regularly scheduled maintenance inspections. Verification of the operable conditions of the outlet works is necessary to enable lowering the level of the reservoir in emergencies.

Institution of a surveillance program and a warning system is necessary should adverse conditions develop at the dam. A formal plan for an orderly evacuation of the downstream population is required to prevent loss of life should the dam fail.

SECTION 5
HYDROLOGY AND HYDRAULICS

5.1 Design Data.

In a 1919 Report of the Pennsylvania Water Supply Commission on the condition of Marshall Lake Dam, the required spillway design capacity for the reported 10 square-mile drainage area was 2,000 cfs (cubic feet per second); whereas the capacity of the spillway was found to be 925 cfs (see paragraph 2.4). The computed spillway capacity in the 1919 Report was based on a spillway length of 75 feet and available head of 2.58 feet, resulting in a spillway discharge coefficient of 3.06. Hydraulic analysis presented in Appendix D employed "critical depth" conditions at the spillway crest for a trapezoidal cross sectional area of an 80-foot long spillway, which better represents the conditions of the constructed spillway. The computed total drainage area above Marshall Lake Dam is 7.88 square miles.

5.2 Experience Data.

The probable flood of record in Pond Creek is the August 1955 flood. Flood stages or flow records at the damsite consist of the following reported observations:

a. The owner reported that State Route 402, downstream of the dam, was overtopped during the August 1955 flood, but that the dam was not overtopped during that flood.

b. Correspondence (3/18/1916, PENNDER files) related to the Meadow Lake Dam (NDI #PA-00628, PENNDER #45-47), located upstream of Marshall Lake Dam, indicates the following:

"..... Heaviest recorded storm prior to 1916 was that of 8/31/1915 where 7 inches of precipitation were recorded within a duration of 3 hours. The observed maximum depth of flow over Marshall Lake Dam spillway was reported to be 3 inches .....".

5.3 Visual Observations.

Based on the visual inspection and field survey described in Section 3 of this report, the observations relevant to hydrology and hydraulics are evaluated below:

a. Embankment: The present low point on top of the dam is at elevation 471.9, or 1.6 feet above the spillway crest elevation. The available head of 2.58 feet over the spillway, reported in 1919 (see paragraph 5.1), implies that the top of the dam was approximately at elevation 472.8. The variation in dam crest elevation shown in Exhibit A-2, Appendix A, is based on a field survey conducted during the November 25, 1980 inspection. Discharge capacity over the dam crest were computed, starting at the low point on the crest and accounting for the aforementioned variation in the dam crest elevations. The methodology used for the overtopping analysis and the computations are presented in Appendix D.

b. Spillway: The spillway crest is at elevation 473.2 and the top of the spillway endwall at the right end of the embankment is at elevation 473. Therefore, should the top of the dam crest be raised to elevation 473, the available head over the spillway crest could be increased from the present 1.6 feet (see paragraph 5.3a) to 2.8 feet. The length of the spillway crest is 80 feet, or 5 feet longer than previously reported (see paragraph 5.1). The adverse slope upstream of the concrete weir and the steep slope of the spillway channel (15%, see also paragraph 2.1b) downstream of the weir, insure that the spillway discharge capacity is controlled by the spillway crest. Spillway discharge computations are based on "critical depth" conditions of the trapezoidal cross sectional area along the spillway crest, bounded by the vertical spillway endwall at the left end of the spillway, and the natural bank at the right end of the spillway (see Exhibit A-2). Should the top of the dam be restored to elevation 473 throughout its entire length, the maximum capacity of the spillway will increase from the present 560 cfs (cubic foot per second) to approximately 1,240 cfs. The drainage divide between Marshall Creek and the spillway outlet channel of the dam is 1.5 feet higher than the left bank of Marshall Creek. The drainage area of Marshall Creek at the spillway outlet channel is approximately 12 square miles, whereas that of Pond Creek at the damsite is 7.88 square miles. Consequently, when the flood stage in Marshall Creek is 1.5 feet above its left bank, overbank flow from Marshall Creek augments the spillway discharge into Pond Creek upstream of State RTE 402 bridge. Conversely, if the water surface at the bend in the spillway outlet channel reaches the elevation of the drainage divide prior to overbank flow conditions in Marshall Creek, discharge from the reservoir into Marshall Creek can be realized. The observed sand bar in the spillway channel most likely resulted by deposition of sediments due to backwater effect from the downstream bridge. The existence of the sand bar and the absence of left bank erosion in Marshall Creek support the assumption that overbank flows in Marshall Creek into Pond Creek occur before the spillway discharges reach the magnitude that can overtop the right bank of the spillway channel. There is no evidence of erosion along the unprotected left bank of the spillway outlet channel downstream of the sharp bend and along the toe of the dam.

c. Reservoir Area: Inflow into Marshall Lake Dam is affected by existing upstream impoundments and swamps (see Paragraph 3.1d). It was judged that routing floods through Rakes Dam (NDI No. PA-00993), shown in Exhibit E-1, would account for the effects of the watershed conditions on the inflow into Marshall Lake Dam. There are no visible indications to suggest drastic changes in the prevailing land use within the watershed which would significantly alter the hydrologic and hydraulic analysis, summarized in paragraph 5.5.

d. Downstream Conditions: Tailwater conditions resulting from less than 0.5 PMF flood flows through and over Pond Creek Bridge at State RTE 402 (see paragraph 3.1e) will not significantly affect the discharge at the dam. Consequently, backwater from the bridge resulting from flood flows in Pond Creek would not affect the overtopping analysis presented in Appendix D. The combined effect of Marshall Creek and Pond Creek

flood flows on the tailwater conditions was not considered in the analysis. Since the hazard area is in close proximity to the dam, the storage effect within the short stretch of the flood plain between the dam and the hazard area is not sufficient to alter the rate of flow computed at the dam site. More than a few lives can be lost and significant property damage incurred should the dam fail. Consequently, Marshall Lake Dam is classified as a high hazard structure.

5.4 Method of Analysis.

Hydrologic and hydraulic evaluation was made in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, Phase I Safety Inspection of Dams. The analysis has been performed utilizing the HEC-1DB program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. A brief description of program capabilities, as well as the input and output data used specifically for this analysis, is presented in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF): According to criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and Hazard potential (high) of Marshall Lake Dam is between one-half Probable Maximum Flood (1/2 PMF) and the full PMF. Because of the small storage capacity of the reservoir and because the dam would be submerged by backwater for flows greater than the 1/2 PMF, the 1/2 PMF is selected as the SDF for the Marshall Lake Dam. The computed 1/2 PMF is 6662 cfs.

b. Results of Analysis: Pertinent results are tabulated in Appendix D. The analysis reveals that under the prevailing top of dam elevations, the present capacity of the spillway is 540 cfs (cubic feet per second), or approximately 4% of the PMF. Should the top of the dam be restored to the top of the spillway endwall (elevation 473), the present capacity of the spillway will increase from 540 cfs to 1,240 cfs, or the approximate equivalent of 10% of the PMF.

Overtopping analysis using the HEC-1DB indicates that the 1/2 PMF would overtop the dam by 3.6 feet. It is assumed that if the dam is overtopped by more than 1.0-foot for a significant duration of time, erosion and failure will occur. Dam breach analyses were performed for 0.2 PMF, the assumed minimum flow which would cause failure, and 0.5 PMF, the SDF. Trial breach widths of 20 feet and 40 feet were used in the analysis with the bottom of the breach being the natural streambed.

The results of the breach analyses indicate that the maximum outflow at failure for the 0.2 PMF would be approximately 4680 cfs. When this flow is routed downstream to the first group of dwellings, the flood stage is increased by approximately 1.0 foot over the water surface that would have occurred had the dam not failed. For the lower reach studied, an increased flood stage of 1.7 feet was calculated. This increase in flood stage constitutes a serious hazard to property and loss of life downstream of the dam. A summary of computer analyses is tabulated at the end of Appendix D.

c. Spillway Adequacy: Because the occurrence of flows less than the 1/2 PMF may cause failure of the dam due to overtopping and thereby increase the hazard to life and property downstream, the spillway is considered to be seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations.

The visual inspection of Marshall Lake Dam is described in Section 3. Observations relevant to the dam's structural stability are evaluated below:

a. Dam: There were no signs of immediate structural instability observed during the inspection. Continued growth of trees on the dam may eventually promote piping through root holes in the embankment.

b. Appurtenant Structures:

(1) Spillway: The spillway, in spite of its poor general appearance, has no serious deficiencies. Continued deterioration of the spillway endwall may result in structural instability of the dam.

(2) Outlet Works: The outlet works were submerged at the time of inspection and cannot be evaluated.

6.2 Design and Construction Data.

There are no documented design or construction data.

6.3 Past Performance.

The dam has performed adequately in the past. No documentation regarding overtopping of the dam was available.

6.4 Stability.

a. Static: The dam is considered to be stable under static loading conditions.

b. Seismic: The dam is located in seismic zone 1. In this zone, if the dam has adequate structural stability under static conditions, it is assumed to be able to withstand the minor seismic forces expected in this zone.

SECTION 7

ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety:

(1) Based on visual inspection, Marshall Lake Dam is judged to be in poor condition. Based on the location of the downstream dwellings and the fact that more than a few lives could be lost should the dam fail, the dam is classified as a high hazard structure. The criteria established for these studies require that the dam pass an SDF of between a 1/2 PMF and the full PMF. Based on the small size and storage capacity of the facility, it is judged that the SDF of 1/2 PMF is appropriate for the Marshall Lake Dam. Under the present conditions, the spillway will pass approximately 4 percent of the PMF without overtopping the dam. As the spillway cannot pass the 1/2 PMF without overtopping the dam; and since overtopping at less than 1/2 PMF would cause failure which would significantly increase hazard to loss of life downstream, the spillway is seriously inadequate and the facility is rated unsafe, non-emergency.

(2) The condition of the outlet works could not be inspected as it was submerged. Ready access to an operable gate or other method of drawing down the reservoir level during emergencies is required.

(3) There is no emergency warning or evacuation plan for the downstream population.

(4) Maintenance of the dam is limited to the left end of the embankment, between the left abutment and the outlet works.

b. Adequacy of Information: The data collected from previously cited dam inspection reports, past performance, visual inspection and computations performed as part of this study are sufficient for Phase I Dam Safety Assessment.

c. Urgency: The recommendations presented in Section 7.2 should be implemented immediately.

d. Necessity for Further Investigations: In order to accomplish some of the remedial measures outlined in paragraph 7.2, further investigation by a Professional Engineer, experienced in the design and construction of dams, will be necessary.

7.2 Recommendations and Remedial Measures.

a. The following investigation and remedial measures are recommended for immediate implementation by the owner. All investigations and design

of remedial measures should be performed under the direction of a Professional Engineer, experienced in the design and construction of dams.

(1) Perform additional hydrologic and hydraulic analyses to more accurately determine the required spillway capacity for the Marshall Lake Dam. Design and construct a spillway that will pass the required SDF without overtopping the dam.

(2) Remove the trees from the embankment and the sandbar from the spillway channel.

(3) Locate and operate the submerged outlet works gate, or provide other emergency means of drawing down the reservoir. If the gate is operable, observe the conditions at the toe when the outlet pipe is subjected to pressure flow. Take appropirate action as necessary.

b. In addition, it is recommended that the owner take the following precautionary operational and maintenance measures:

(1) Develop a detailed emergency operation procedure and warning system to facilitate timely and orderly evacuation of the downstream population if any hazardous conditions at the dam are observed.

(2) When warnings of a storm of major proportions are given by the National Weather Service, activate the emergency operation and warning system procedures.

(3) After satisfactory implementation of the remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a Professional Engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

APPENDIX A

VISUAL INSPECTION - CHECKLIST AND FIELD SKETCHES

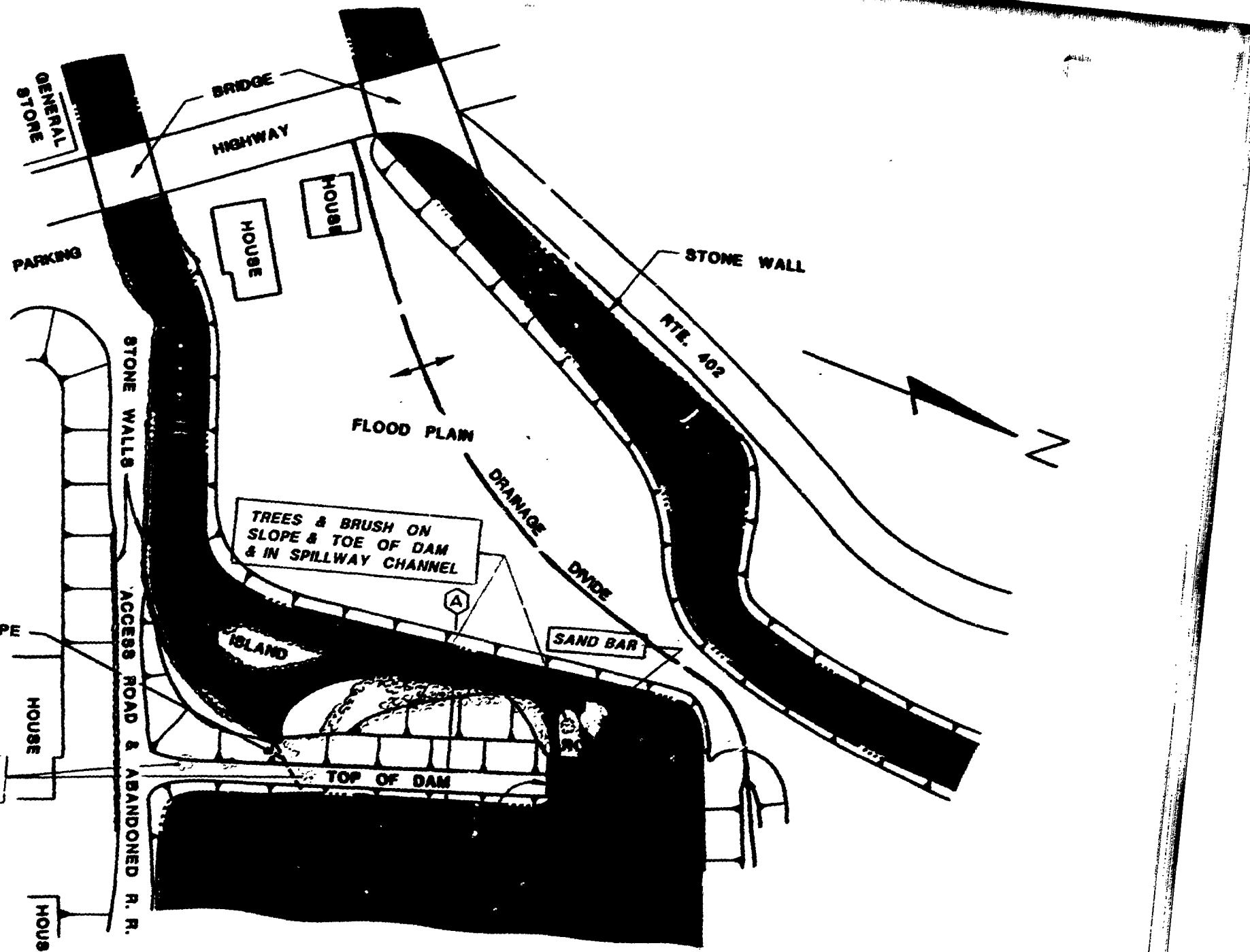
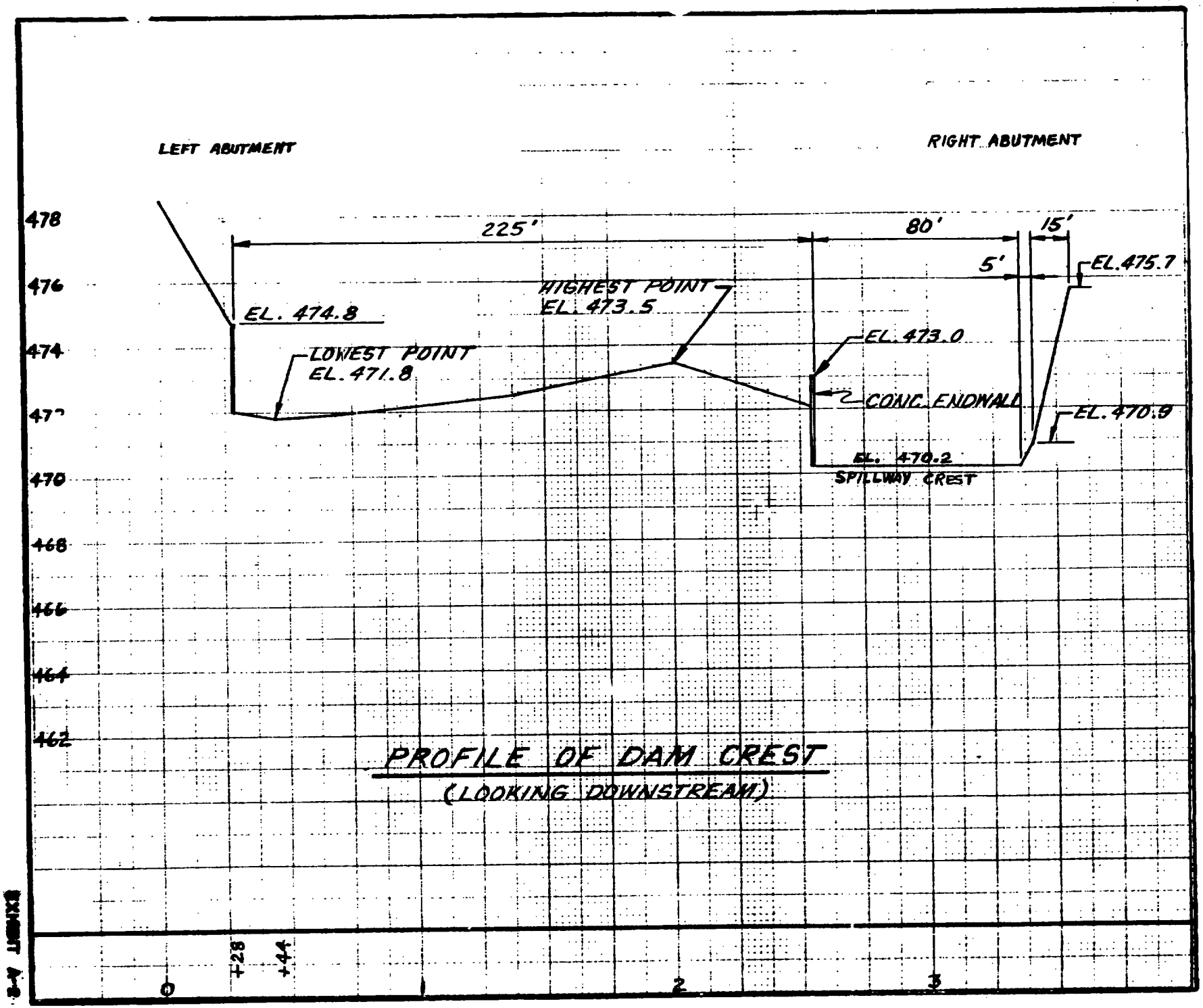


EXHIBIT A-1

MARSHALL LAKE DAM
GENERAL PLAN - FIELD INSPECTION NOTES



PROFILE OF DAM CREST

(LOOKING DOWNSTREAM)

EXHIBIT A-4

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

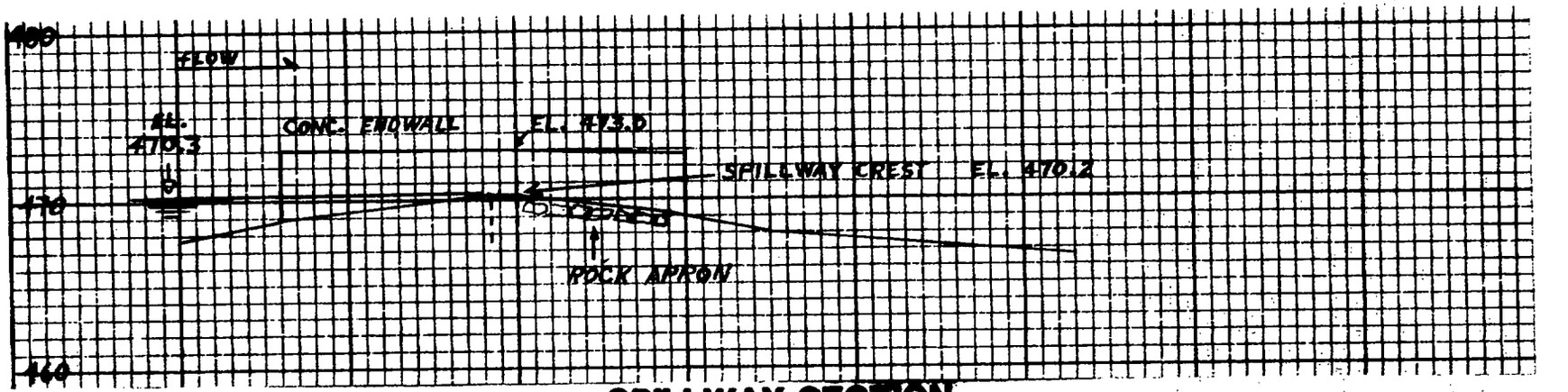
SHEET NO _____ OF _____

CALCULATED BY _____ DATE _____

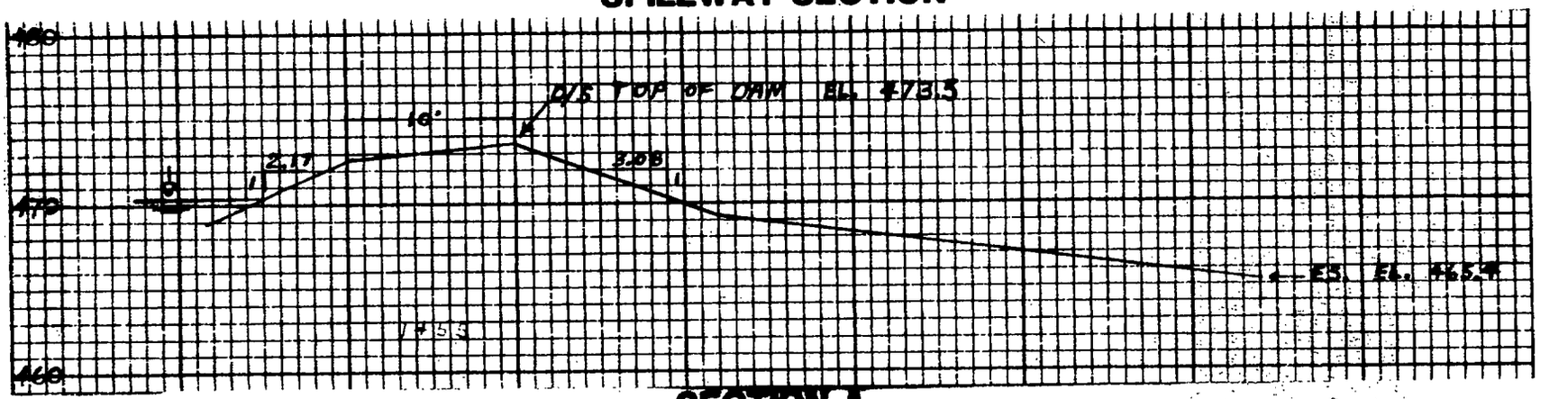
CHECKED BY _____ DATE _____

SCALE _____

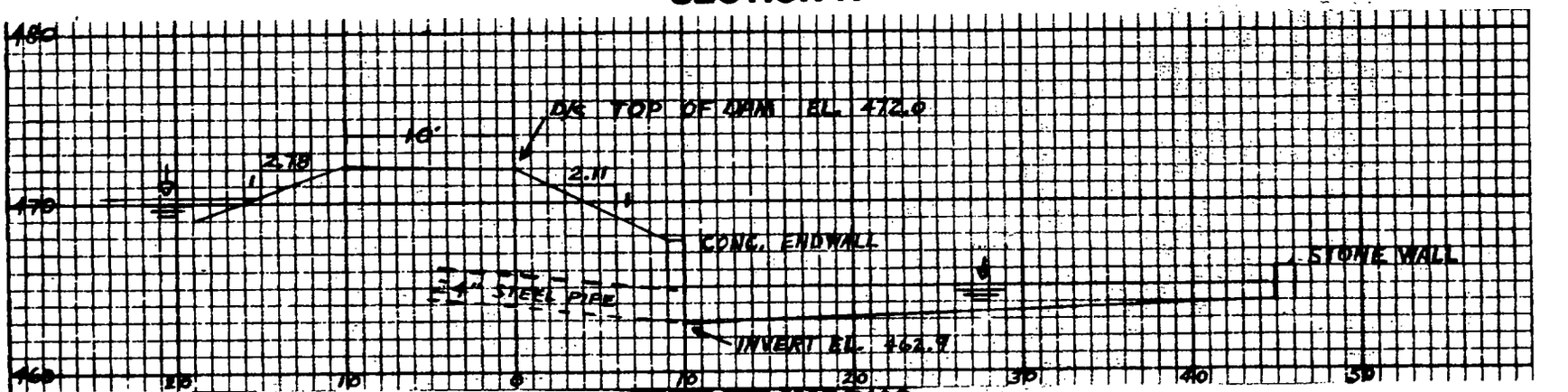
TYPICAL DAM SECTIONS



SPILLWAY SECTION



SECTION A



OUTLET WORKS

EXHIBIT A-4

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Marshall Lake Dam STATE Pennsylvania COUNTY Monroe

NDI # PA — 00985 PENNDER # 45-52

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION November 25, 1980 WEATHER Cloudy TEMPERATURE 43°F @ 11:00 a.m.

POOL ELEVATION AT TIME OF INSPECTION 470.3 M.S.L.

TAILWATER AT TIME OF INSPECTION 465.0 M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
Gideon Yachin - Engineer	R. C. MacDonough, Owner	
Gerald Branthoover, Geologist	Mr. MacDonough's son	
Ronald Mather - Surveyor		
Wayne Himes - Surveyor		

RECORDED BY Gideon Yachin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00985
SURFACE CRACKS	None observed
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Straight alignment; variable top elevation (see Profile, Exhibit A-2). Crest width varies from 9 feet at the left abutment, to 14 feet at the right abutment.
RIPRAP FAILURES	No riprap
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Vertical wall at left abutment. Vertical spillway endwall at the junction with the embankment, on the right abutment.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00985
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	Heavy brush along the downstream toe near spillway
ANY NOTICEABLE SEEPAGE	None through embankment
STAFF GAGE AND RECORDER	None
DRAINS	None
ROCK OUTCROPS	On right abutment of spillway; Near-vertical dip; strike perpendicular to spillway crest
DAM FOUNDATION TREES, OTHER	Trees on top of dam (+12" diameter) and near toe of dam

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00985
INTAKE STRUCTURE	Submerged
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	24" diameter steel pipe
OUTLET STRUCTURE	End wall
OUTLET CHANNEL	Direct discharge into spillway channel
GATE(S) AND OPERATIONAL EQUIPMENT	Reported upstream wooden gate (by Owner); No hoisting device is visible
CONCRETE SURFACES, CRACKS, SPALLING JOINTS	Not applicable

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00985
TYPE AND CONDITION	Concrete cap with sloping downstream apron of concrete with stone rubble; A small island (sediment deposit) on the left end of spillway (18" dia. tree)
APPROACH CHANNEL	Same width as spillway; bottom not visible
SPILLWAY CHANNEL AND SIDEWALLS	Concrete stepped wall on the right dam abutment spillway ends at natural ground on the right end of crest.
STILLING BASIN PLUNGE POOL	None
DISCHARGE CHANNEL	Sharp bend to the left; parallels toe of dam along its entire length; Sharp bend to the right (90^0 to dam) near left dam abutment; Formation of island (divided flow) near left abutment (both island and left bank of channel protected with slabby dry rock walls).
BRIDGE AND PIERS EMERGENCY GATES	None

SERVICE SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00985
TYPE AND CONDITION	None
APPROACH CHANNEL	
OUTLET STRUCTURE	
DISCHARGE CHANNEL	

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00985
MONUMENTATION SURVEYS	None
OBSERVATION WELLS	None
WEIRS	None
PIEZOMETERS	None
OTHERS	None
OPERATION AND MAINTENANCE DATA	Not Available

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00985
SLOPES: RESERVOIR	Steep on right bank; Terraced on left bank
SEDIMENTATION	None observed at upstream end of lake
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Sharp bend (protected with stone on left bank), immediately downstream of dam. Control at bridge under Route 402; Confluence with Marshall Creek 1000'± downstream; Bridge under Route (BR) 209; below confluence,
SLOPES: CHANNEL VALLEY	Broad flood plain with steep valley slopes (600± wide)
APPROXIMATE NUMBER OF HOMES AND POPULATION	4 homes and 8 business establishments Estimated maximum occupancy - 80 persons

APPENDIX B

ENGINEERING DATA - CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Marshall Lake Dam

ITEM	REMARKS	NDI# PA - 00985
PERSONS INTERVIEWED AND TITLE	Richard C. MacDonough, Owner.	
REGIONAL VICINITY MAP	See Exhibit E-1; Appendix E	
CONSTRUCTION HISTORY	Information not available. Constructed between 1904 and 1909.	
AVAILABLE DRAWINGS	None	
TYPICAL DAM SECTIONS	See Exhibit A-3	
OUTLETS. PLAN DETAILS DISCHARGE RATINGS	24-inch-diameter steel pipe None Available None Available Not Available	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00985
SPILLWAY PLAN SECTION DETAILS	Construction plans are not available See Exhibits A-1, A-2 and A-3, Appendix A	
OPERATING EQUIP- MENT PLANS AND DETAILS	None Available	
DESIGN REPORTS	None Available	
GEOLOGY REPORTS	None Available	
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None Available	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None Available	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00985
BORROW SOURCES	Not known	
POST CONSTRUCTION DAM SURVEYS	None available	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Inspection Reports on file with PENNDER (No. 45-052)	
HIGH POOL RECORDS	Maximum discharge without overtopping 8/19/1955 (reported by owner). El. 471.2 on 8/01/1913 (information obtained from correspondence file of Meadow Lake Dam, PENNDER No. 45-047)	
MONITORING SYSTEMS	None	
MODIFICATIONS	Not known	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

NDI# PA - 00985

ITEM	REMARKS
PRIOR ACCIDENTS OR FAILURES	None reported
MAINTENANCE RECORDS MANUAL	Not available
OPERATION: RECORDS MANUAL	Not available
OPERATIONAL PROCEDURES	Self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None existing
MISCELLANEOUS	

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # 00985
PENNDER ID # 45-52

SIZE OF DRAINAGE AREA: 7.88 square miles

ELEVATION TOP NORMAL POOL: 470.2 STORAGE CAPACITY 40 Acre-Feet

ELEVATION TOP FLOOD CONTROL POOL NA STORAGE CAPACITY NA

ELEVATION MAXIMUM DESIGN POOL Unknown STORAGE CAPACITY: Unknown

ELEVATION TOP DAM: 471.8 STORAGE CAPACITY: 62 Acre-Feet

SPILLWAY DATA

CREST ELEVATION: 470.2

TYPE: Concrete Weir

CREST LENGTH: 80 feet

CHANNEL LENGTH: 240 feet long outlet channel

SPILLOVER LOCATION: Right Abutment

NUMBER AND TYPE OF GATES: None

OUTLET WORKS

TYPE: 24-inch diameter steel pipe

LOCATION: Near Left Abutment

ENTRANCE INVERTS: Unknown

EXIT INVERTS: 462.9

EMERGENCY DRAWDOWN FACILITIES: Reported wooden gate at inlet. Method of hoisting, access and operable condition of facilities were not verified.

HYDROMETEOROLOGICAL GAGES

TYPE: None

LOCATION: None

RECORDS: None

MAXIMUM NON-DAMAGING DISCHARGE: 560 cfs (computed)

APPENDIX C

PHOTOGRAPHS

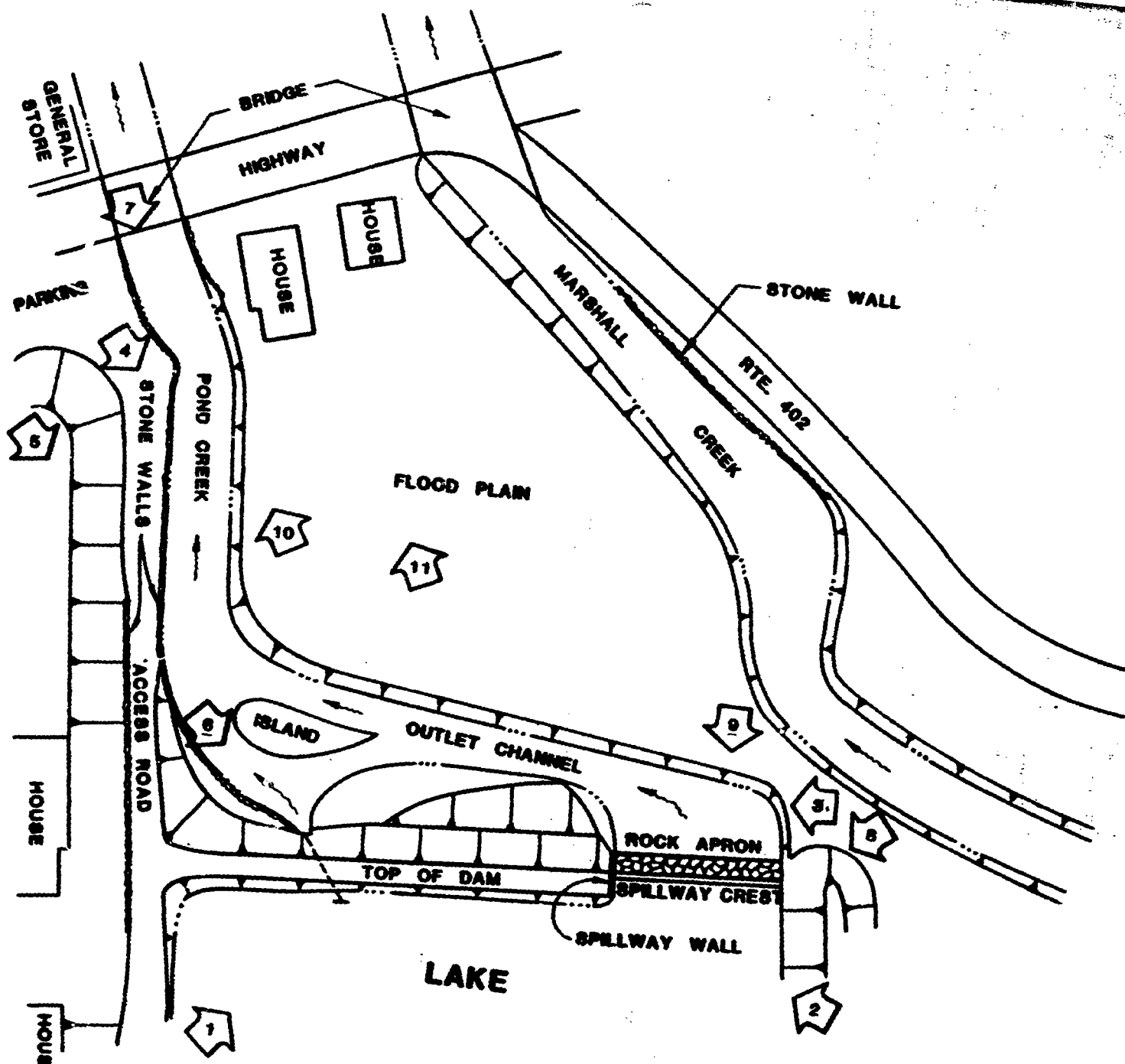


EXHIBIT 9-1

MARSHALL LAKE DAM
PHOTOGRAPHS LOCATION MAP

1. UPSTREAM SLOPE . LOOKING FROM LEFT BANK (SPILLWAY LOCATED NEAR RIGHT ABUTMENT)

2. LEFT SPILLWAY WALL (FROM RIGHT BANK)

3. SPILLWAY OUTLET CHANNEL (LOOKING DOWNSTREAM)

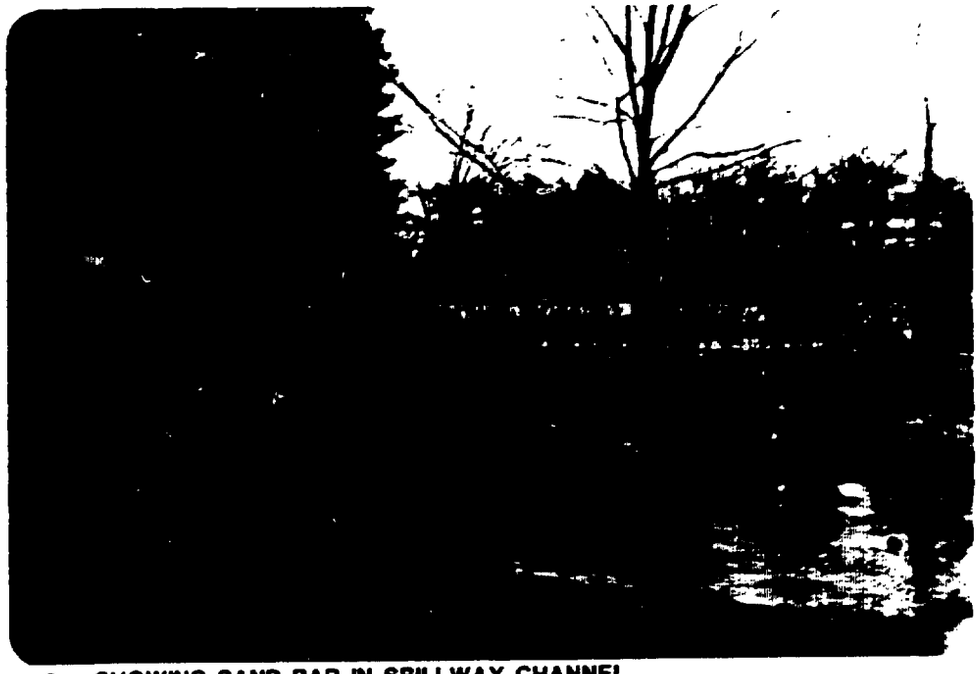
4. SPILLWAY OUTLET CHANNEL (LOOKING UPSTREAM) SHOWING UPSTREAM END OF ISLAND (DAM IN BACKROUND)

5. DOWNSTREAM SLOPE AT LEFT ABUTMENT OUTLET WORKS BEHIND TREE ON ISLAND

6. DOWNSTREAM SLOPE AT LEFT ABUTMENT SHOWING OUTLET WORKS &DOWNSTREAM BANK PROTECTION

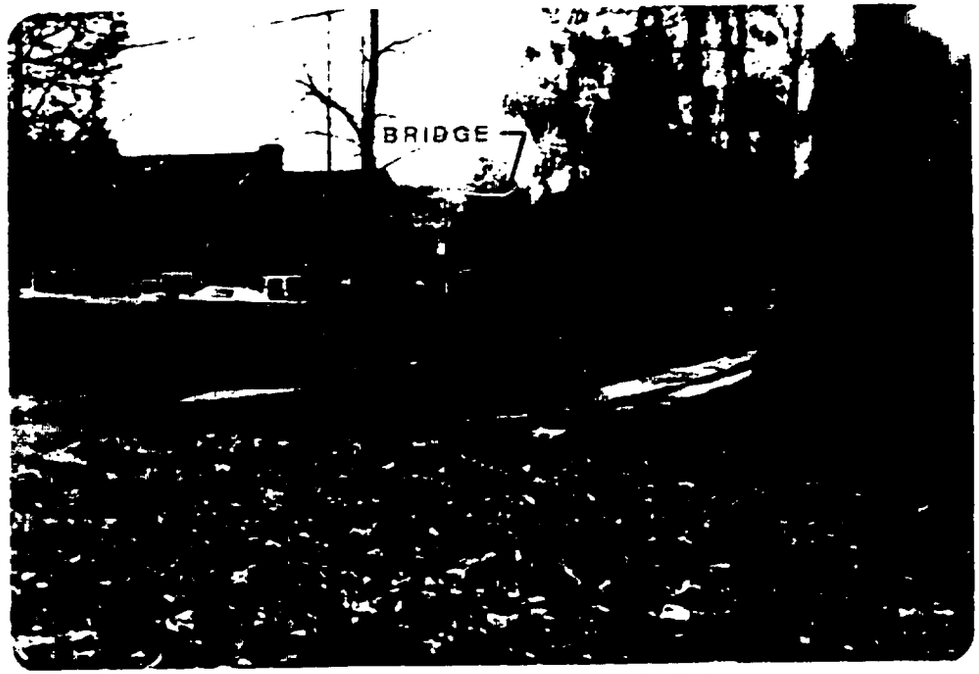
7. LOOKING UPSTREAM FROM 402 BRIDGE (DAM IN BACKGROUND)

8. RIGHT END OF SPILLWAY



9. SHOWING SAND BAR IN SPILLWAY CHANNEL

8 & 9 EMERGENCY SPILLWAY , LOOKING UPSTREAM



10. STREAM CHANNEL AT RTE. 402 BRIDGE SHOWING LEFT BANK PROTECTION & GENERAL STORE

11. FLOOD PLAIN AT RTE. 402, SHOWING FLOODING HAZARD BELOW THE DAM

APPENDIX D

HYDROLOGY AND HYDRAULICS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY INVESTIGATIONS

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the over-topping potential of the dam, and (2) estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam over-topping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would over-top the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program, refer to the Users Manual for the Flood Hydrograph Package (HEC-1), Dam Safety Investigations prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB MARSHALL LAKE NDI-PA
SHEET NO. 1 OF
CALCULATED BY [signature] DATE 5/81
CHECKED BY DATE
SCALE

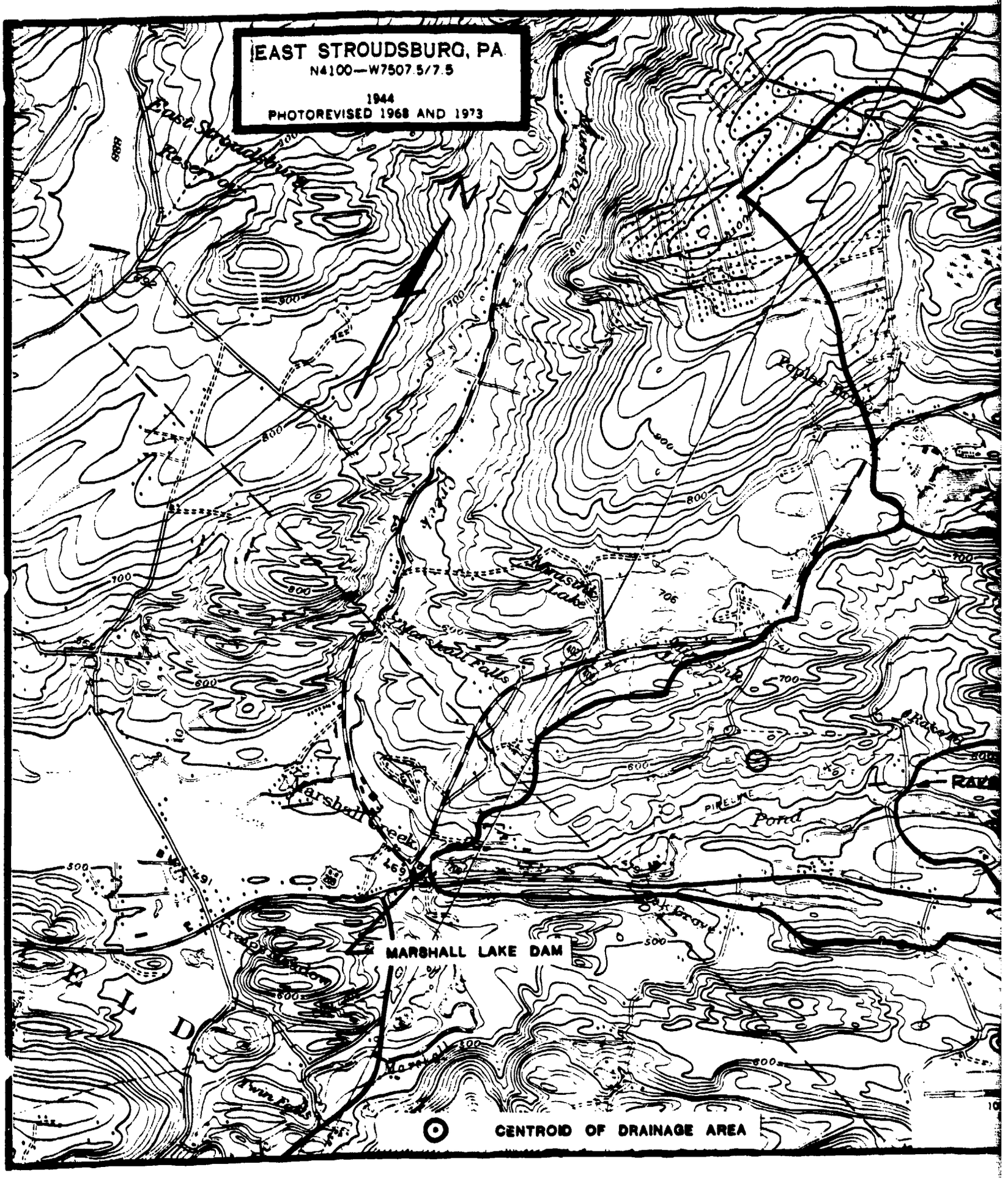
GENERAL DATA - MARSHALL LAKE

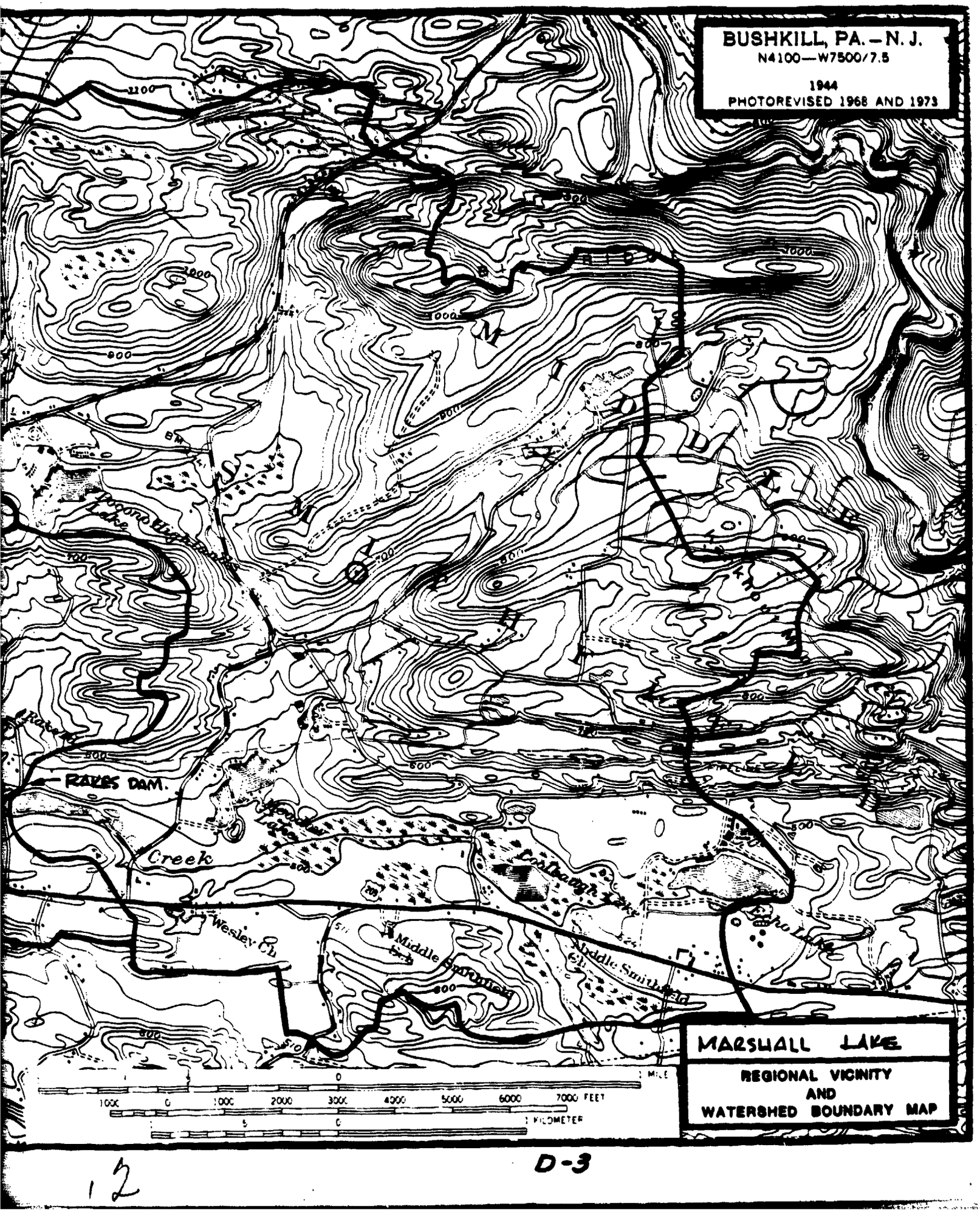
RIVER BASIN	DELAWARE
STREAM NAME	POND CREEK trib. to Marshall Creek
NDI I.D. NO	PA-0985
DER I.D. NO	45-052
OWNER	R. C. MacDonough
LOCATION	SMITHFIELD TWP.
CO.	MONROE
QUAD.	E. STROUDSBURG & BUSHKILL
LAT.	41°-02'-35"
LONG.	75°-07'-38"
SIZE	SMALL
HAZARD	HIGH HAZARD
DRAINAGE AREA	7.88 mi²

Watershed Features

Upstream Dams - Rakes Pond - under study by Woodward Clyde Assoc.
- MEADOW LAKE
- Coolbaugh Lake
- Pocono Highlands Lake

note: Rakes Pond immediately upstream and the effects of the upstream dams are included in the Woodward Clyde Analysis.


EAST STROUDSBURG, PA.
N4100—W7507.5/7.5
1944
PHOTOREVISED 1968 AND 1973
East Stroudsburg Reservoir
Marshall Creek
Marshall Lake
Marshall Falls
Poplar Run
Pond
PIPELINE
Marshall Creek
MARSHALL LAKE DAM
Twin Falls
CENTROID OF DRAINAGE AREA


BUSHKILL, PA.—N. J.
N4100—W7500/7.5
1944
PHOTOREVISED 1968 AND 1973
Pocono Highlands
Lake
RAKES DAM.
Creek
Wesley Ch.
Middle Smithfield
Middle Smithfield
Lookaway Lake
Echo Lake
MARSHALL LAKE
REGIONAL VICINITY
AND
WATERSHED BOUNDARY MAP
MILE
0
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
KILOMETER
0

12

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

NDI - PA.

SHEET NO. ... OF ...

CALCULATED BY ... DATE 5/81

CHECKED BY ... DATE ...

RAINFALL & HYDROGRAPH DATA

Rainfall

Basin — DELAWARE

Ref. — HYDROMETEROLOGICAL REPORT NO. 33

Zone — 1

PMP — 21.8"

INDEX RAINFALL

Duration	Percent
6 hr.	111
12 hr	123
24 hr	133
48 hr	142

Hydrograph

Zone 1

C_P = 0.45

C_T = 1.23

Drainage Area No. A-1 - RAKES POND DAM

T_p = 2.33 (FROM WOODWARDCLYDE)
(Ck. comp. 2.30 ok)

DR. AREA = 6.31 mi^2

Drainage Area No. A-2 - MARSHALL LAKE SUB AREA

$T_p = C_T (LL_{ca})^{0.3}$ L = 1.4

T_p = 1.17 L_{ca} = 0.6

DRAINAGE AREA = 1.57 mi^2

MARSHALL LAKE DAM IS HIGH HAZARD ∴ DAM BREAK ANALYIS REQUIRED IF DAM is OVERTOPPED BY FLOWS < ½ PMF

ANALYSIS PROCEDURE:

1. COMPUTE INFLOW INTO RAKES POND DAM (USE WOODWARD .. DATA)
2. ROUTE FLOW THRU RAKES POND DAM (" " ")
3. ROUTE FLOW TO MARSHALL LAKE
4. COMPUTE SUBAREA A2 RUNOFF
5. COMBINE FLOWS FROM A1 & A2
6. ROUTE FLOWS THRU MARSHALL LAKE
7. ROUTE FLOWS TO DAMAGE CENTER
8. IF OVERTOPPING SIGNIFICANT RUN DAM BREAK

RAKES DAM SPILLWAY RATING & STAGE/STORAGE
USE WOODWARD CLYDE DATA

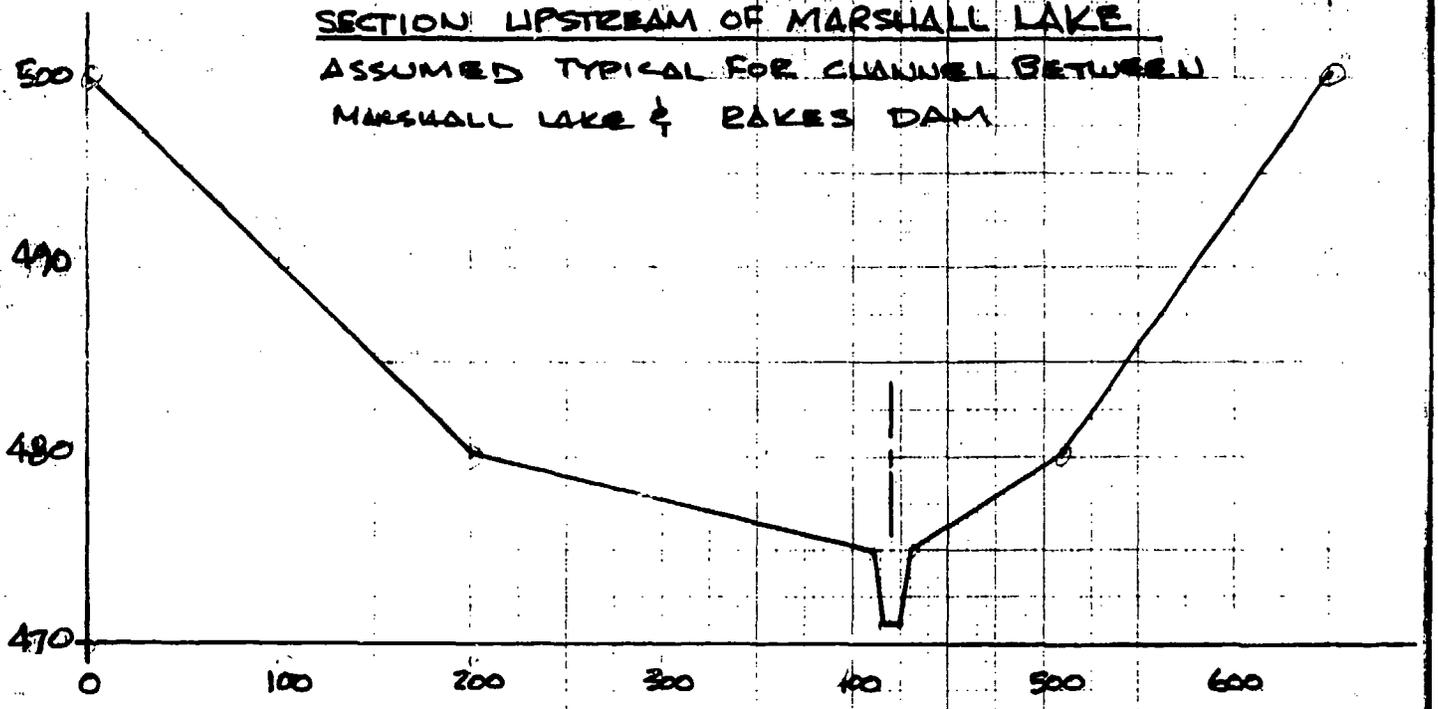
```
K1                          OUTFLOW HYDROGRAPH - RAKE DAM
Y                                    1       1
Y1     1                                                -494.9        -1
Y4 494.9495.9   496.9   497.9   498.9   499.9   500.9
Y5 0.    354.   990.    1699.   2600.   3634.   4776.
$A 0.    14.7   126.
$E 490. 495.    500.
$$ 494.9
$D 498.6
$L 0.    23.    205.    345.
$V 498.6499.    499.2   499.6
```

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB MARSHALL LAKE NDI-PA
SHEET NO ____ OF ____
CALCULATED BY JJW DATE 5/81
CHECKED BY ____ DATE ____
SCALE ____

SECTION UPSTREAM OF MARSHALL LAKE

ASSUMED TYPICAL FOR CHANNEL BETWEEN MARSHALL LAKE & BAKES DAM



$n_{CHANNEL}$ = 0.035
$n_{OVERBANK}$ = 0.065
ELNVRT = 471.0
ELMAX = 500
REACH LENGTH = 4800 '
SLOPE = 0.002 ft/ft

COORDINATES

DIST.	ELEV.
0	500
200	480
410	475
415	471
420	471
425	475
510	480
610	500

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

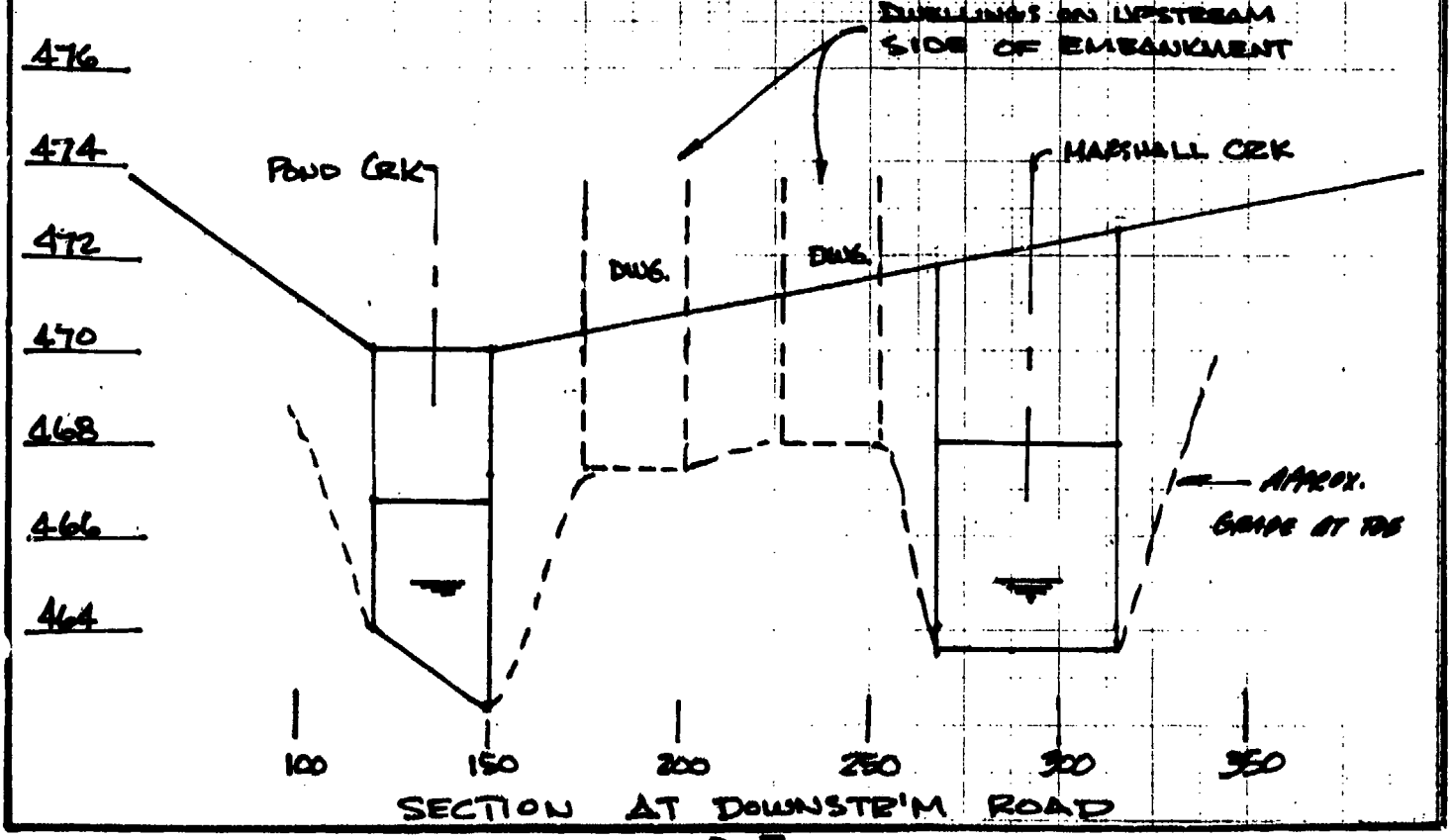
SHEET NO. _____ OF _____
CALCULATED BY sfm DATE 5/81
CHECKED BY _____ DATE _____
SCALE _____

MARSHALL LAKE - SPILLWAY RATING

1.) CHECK T.W. CONDITIONS. 300 Ft. DOWNSTREAM OF THE DAM IS A ROAD EMBANKMENT AND TWO BRIDGES. THE ELEVATION OF THE BRIDGE DECK IS 470.0 AND THE SPILLWAY CREST ELEVATION IS 470.2

THE PROBLEM IS COMPOUNDED BY MARSHALL CREEK WHICH MUST BE CONVEYED THROUGH THIS SECTION WITH THE DISCHARGE FROM THE DAM. THE DRAINAGE AREA FOR MARSHALL CREEK IS ± 50. Mi AT THIS POINT AND IT IS REASONABLE TO ASSUME THAT HIGH STAGES* ON BOTH STREAMS CAN AND WOULD OCCUR CONCURRENTLY

*(NOT NECESSARILY CO-INCIDENT PEAKS)



SECTION AT DOWNSTR'M ROAD

(SPILLWAY RATING CONTINUED)

2.) ANALYSIS PROCEDURE

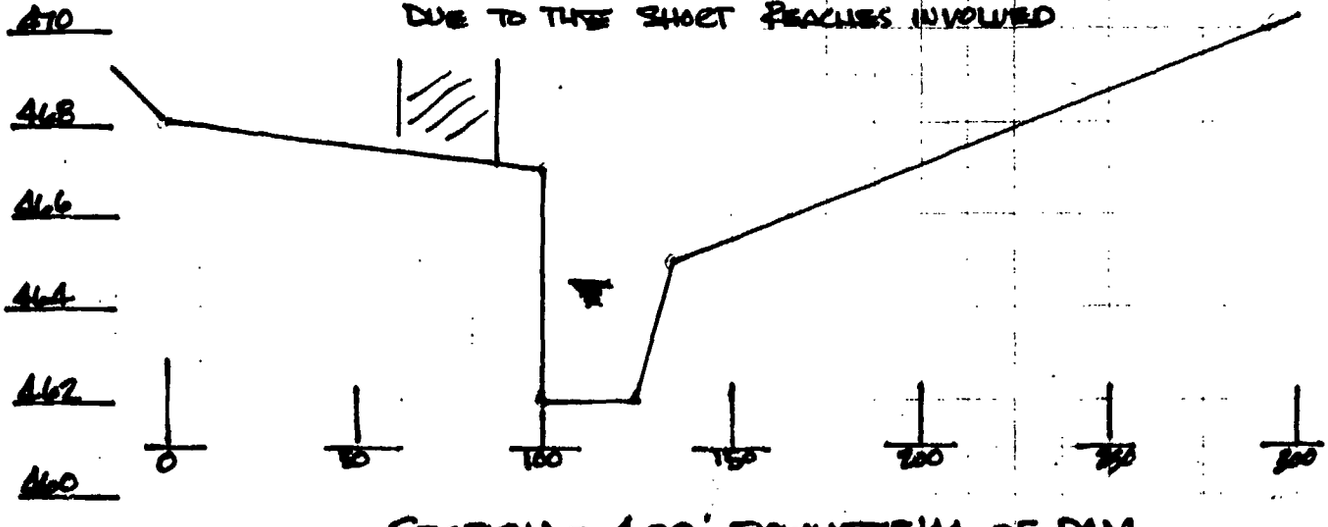
(a) ASSUME FLOW IN MARSHALL CREEK REQUIRES 100% OF THE RIGHT CHANNEL AND BRIDGE CONVEYANCE CAPACITY

(b) COMPUTE NORMAL DEPTH FOR A SECTION 180' BELOW THE ROAD SECTION

(c) RATE THE BRIDGE SECTION USING THE WATER SURFACE PROJECTED FROM THE DOWNSTREAM SECTION AS TAILWATER FOR THE BRIDGE. ASSUME WATER SURFACE SLOPE = CHANNEL SLOPE
ASSUME ORIFACE FLOW IN BRIDGE OPENING AND CRITICAL DEPTH FLOW OVER THE ROAD EMBANKMENT.

(d) PROJECT WATERSURFACE TO SPILLWAY ASSUMING W.S. SLOPE = STREAM SLOPE

(e) CHANNEL ROUTING IS ASSUMED INSIGNIFICANT DUE TO THE SHORT REACHES INVOLVED



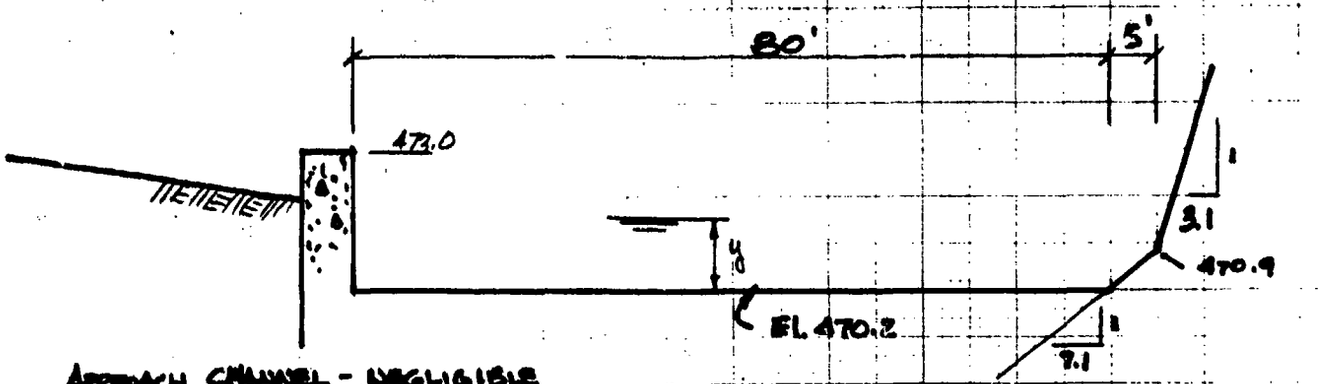
SECTION - 400' DOWNSTR'M OF DAM
- 100' DOWNSTR'M OF ROAD

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO. —
CALCULATED BY _____ DATE 6/81
CHECKED BY _____ DATE _____
JOB MARSHALL LAKE SPILLWAY

SPILLWAY SECTION

NOTE: NO LOW LEVEL OUTLET



APPROACH CHANNEL - NEGLIGIBLE

DOWNSTR. APRON & CHANNEL 14.7%

∴ RATE SPILLWAY AS CRITICAL DEPTH SECTION $\frac{Q^2}{g} = \frac{A^3}{T}$ $R_m = A/T$ $E_o = y_c + \frac{V_c^2}{2g}$

SPILLWAY RATING

POOL ELEV	FLOW (cfs)	Y (ft.)	AREA (sqft)	T (ft.)
470.6	75	0.30	24.3	82.1
471.3	332	0.80	66.3	85.2
472.1	697	1.30	109.3	86.8
472.8	1145	1.80	153.2	88.3
473.6	1665	2.30	197.8	89.9
474.3	2250	2.80	243.1	91.4
475.0	2895	3.30	289.3	93.0
475.7	3597	3.80	336.2	94.5
476.4	4354	4.30	383.9	96.1
477.2	5162	4.80	432.3	97.6
477.9	6021	5.30	481.6	99.2
478.6	6929	5.80	531.6	100.7

BASIC PROGRAM

```
5PRINT :PRINTUSING 101:PRINTUSING 102:PRINTUSING 103:PRINT
10 FOR E=470.5 TO 476.0 STEP .5
20 Y=E-470.2:Y1=Y-.7:IF Y1]0THEN 30:Y1=0
30 Y2=E-470.2:IF Y2[.7THEN 40:Y2=.7
40 A=80*Y+3.75*Y2*Y2+5*Y1+1.55*Y1*Y1
50 T=80+7.1*Y2+3.1*Y1
60 Q=SQR(32.2*A*A*A/T):Q=INT(Q+.5)
70 EO=470.2+Y+Q*Q/A/A/64.4
80 PRINTUSING 100,EO,Q,Y,A,T
90 NEXT E
100% ###.#   #####    #.##   ###.#   ###.#
101%  POOL    FLOW      Y     AREA      T
102%  ELEV     cfs      ft.   sqft      ft.
103%  ----    -----    ----   -----    ----
```

E = Trial W.S. Elev.
y = E - 470.2
A = AREA
T = TOP WIDTH
Q = FLOW = $\sqrt{\frac{A^3}{T}}$
Eo = Pool Elev.
Eo = E + $\frac{V^2}{2g}$

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

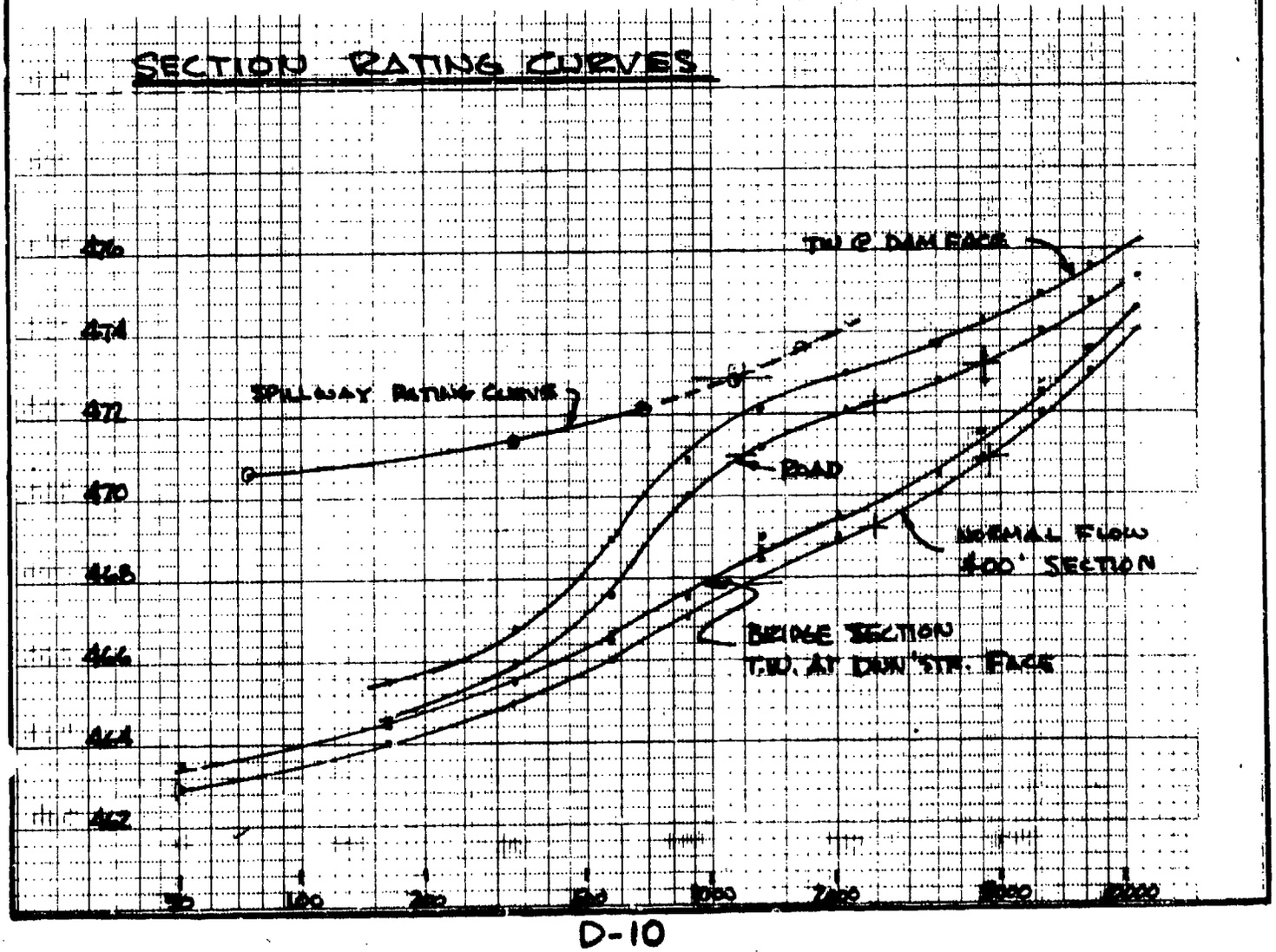
SHEET NO. ____
COMPUTED BY [signature] DATE 6/81
CHECKED BY ____ DATE ____
SCALE ____

NORMAL DEPTH RATING CURVE
AT 400' SECTION
& BRIDGE FACE

FLOW CFS	SECT. ELEV.	BR. FACE ELEV.
51	463.0	463.5
166	464.0	464.5
332	465.0	465.5
573	466.0	466.5
873	467.0	467.5
1326	468.0	468.5
2143	469.0	469.5
3253	470.0	470.5
4597	471.0	471.5
6281	472.0	472.5
8331	473.0	473.5
10775	474.0	474.5

BRIDGE / ROAD EMB.
RATING CURVE

CFS FLOW	ELEV. T.W.	ELEV. BRIDGE	ELEV. DAM FACE
166	464.5	464.6	465.5
332	465.5	465.9	466.8
573	466.5	467.6	468.5
873	467.5	470.0	470.9
1326	468.5	471.2	472.1
2143	469.5	472.1	473.0
3253	470.5	472.8	473.7
4597	471.5	473.4	474.3
6281	472.5	474.0	474.9
8331	473.5	474.7	475.6
10775	474.5	475.3	476.2

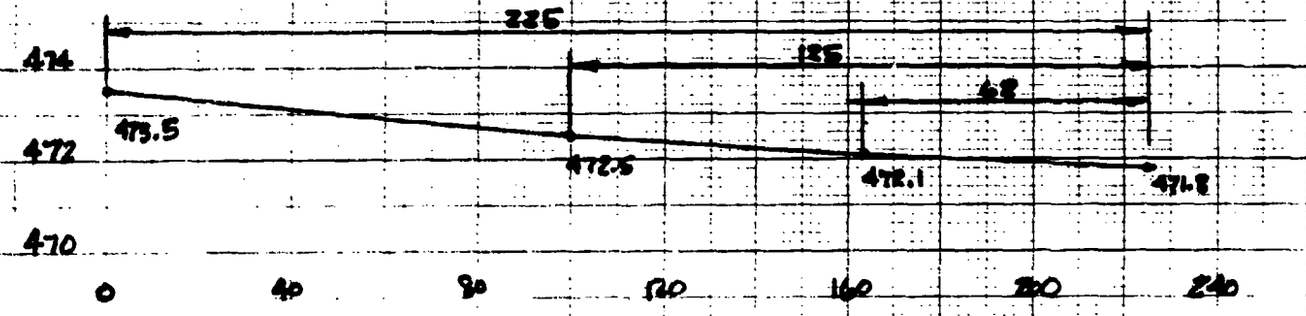


GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB NDI - PA
SHEET NO ____ OF ____
CALCULATED BY SPW DATE 6/91
CHECKED BY ____ DATE ____
MARSHALL LOCK

ASSUME: TAILWATER INSUFFICIENT TO CAUSE BACKWATER CONDITIONS TO EXIST FOR SPILLWAY FLOW

TRANSFORMED TOP OF DAM SECTION



STORAGE DATA

ELEV.	AREA (Ac.)	
470.2	11	NORMAL POOL
480.0	70	CONTOUR

STREAM El. @ DAM TOE = 462.5
EST. STORAGE AS $\frac{11 \times 7.5}{2} \times 40$ Ac.Ft.

BOT. ELEV. FOR HECIDB = $470.2 - \frac{3 \times 40}{11}$ ≈ 459.3

{ RUN OVERTOPPING ANALYSIS }

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO
CALCULATED BY [redacted] DATE 6/87
CHECKED BY DATE
SCALE

SUMMARY OF DAM BREACH ANALYSIS

LOCATION	%PMF	UNBREACHED CONDITION FLOW	UNBREACHED CONDITION STAGE	40' WIDE BREACH FLOW	40' WIDE BREACH STAGE	Δ STAGE (ft.)
SECT @ DAM CREST	20	2490	473.6	4684	[redacted]	—
SECT @ ROAD	20	2490	472.2	4684	473.2	+ 1.0
SECT @ 400' DWNSTR.	20	2490	469.2	4684	470.9	+ 1.7

LOCATION	%PMF	* COND. JUST PRIOR TO BR. FLOW	* COND. JUST PRIOR TO BR. STAGE	40' WIDER BREACH FLOW	40' WIDER BREACH STAGE	Δ STAGE (ft.)
SECT @ DAM CREST	20	1200.0	472.9	4684	[redacted]	—
SECT @ ROAD	20	1200.0	471.0	4684	473.2	+ 2.2
SECT @ 400' DWNSTR.	20	1200.0	467.8	4684	470.9	+ 3.1

* MAX. DEPTH OVER DAM ASSUMED TO OCCUR 15 min. PRIOR TO BREACH (OR START OF BREACH CONDITION)

{ Elevations from Stage / Discharge Curves pg. D8 }

NOTE: THERE ARE NO SIGNIFICANT FLOW / STAGE CHANGES FOR A 20' OR 40' BREACH UNDER 0.5 PMF FLOODING CONDITIONS

{ HEC-1DB PRINT OUTS ATTACHED }

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1          A1       NATIONAL DAM INSPECTION PROGRAM
    2          A2       OVERTOPPING ANALYSIS
    3          A3       MARSHALL LAKE DAM PA0985
    4          B    150       0       15        0        0        0        0        0       -4        0
    5          B1     5       0        0        0        0        0        0        0        0        0
    6          J      1      .6        1        0        0        0        0        0        0        0
    7          J1    .1      .2       .3       .4       .5        1        0        0        0        0
    8          K      0       1        0        0        0        0        1        0        0        0
    9          K1       INFLOW RAKES POND DAM
   10          M      1       1     6.31        0     7.88        0        0        0        1        0
   11          P      0    21.8      111      123      133      142        0        0        0        0
   12          T      0       0        0        0        0        0        1      .05        0        0
   13          W   2.33     .45        0        0        0        0        0        0        0        0
   14          X   -1.5    -.05        2        0        0        0        0        0        0        0
   15          K      1       2        0        0        0        0        1        0        0        0
   16          K1       ROUTE THRU RAKES POND
   17          Y      0       0        0        1        1        0        0        0        0        0
   18          Y1     1       0        0        0        0        0    494.9       -1        0        0
   19          Y4 494.9   495.9    496.9    497.9    498.9    499.9    500.9        0        0        0
   20          Y5     0     354      990     1699     2600     3634     4776        0        0        0
   21          SA     0    14.7      126        0        0        0        0        0        0        0
   22          SE   490     498      500        0        0        0        0        0        0        0
   23          SS 494.9       0        0        0        0        0        0        0        0        0
   24          SO 498.6       0        0        0        0        0        0        0        0        0
   25          SL     0      23      205      345        0        0        0        0        0        0
   26          SV 498.6     499    499.2    499.6        0        0        0        0        0        0
   27          K      1       3        0        0        0        0        1        0        0        0
   28          K1       ROUTE RAKES OUTFLOW TO MARSHALL LAKE
   29          Y      0       0        0        1        1        0        0        0        0        0
   30          Y1     1       0        0        0        0        0        0        0        0        0
   31          Y6  .065    .035     .065      471      500     4P00     .002        0        0        0
   32          Y7     0     500      200      480      410      475      415      471      420      471
   33          YI   425     475      510      480      610      500        0        0        0        0
   34          K      0       4        0        0        0        0        1        0        0        0
   35          K1       PARTIALINFLOW TO MARSHALL LAKE
   36          M      1       1     1.57        0     7.88        0        0        0        1        0
   37          P      0    21.8      111      123      133      142        0        0        0        0
   38          T      0       0        0        0        0        0        1      .05        0        0
   39          W   1.17     .45        0        0        0        0        0        0        0        0
   40          X   -1.5    -.05        2        0        0        0        0        0        0        0
   41          K      2       5        0        0        0        0        1        0        0        0
   42          K1       COMBINE RAKES OUTFLOW & SUBAREA A2
   43          K      1       6        0        0        0        0        1        0        0        0
   44          K1       ROUTE THRU MARSHALL LAKE
   45          Y      0       0        0        1        1        0        0        0        0        0
   46          Y1     1       0        0        0        0        0   -470.2       -1        0        0
   47          Y4 470.2   470.6    471.3    472.1    472.8    473.6    474.3    475.0    475.7    476.4
   48          Y4 477.2   477.9    478.6        0        0        0        0        0        0        0
   49          Y5     0      75      332      697     1145     1665     2250     2895     3597     4354
   50          Y5  5162    6021     6929        0        0        0        0        0        0        0
```

E1-0

```
51          $A      0      11      70       0       0       0       0       0       0       0
52          $E  455.3   470.2     480       0       0       0       0       0       0       0
53          $S  470.2       0       0       0       0       0       0       0       0       0
54          $D  471.8       0       0       0       0       0       0       0       0       0
55          $L      0      62     125     225       0       0       0       0       0       0
56          $V  471.8   472.1   472.5   473.5       0       0       0       0       0       0
57          K      99       0       0       0       0       0       0       0       0       0
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE= 81/06/16.
TIME= 13.58.12.

NATIONAL DAM INSPECTION PROGRAM
OVERTOPPING ANALYSIS
MARSHALL LAKE DAM PA0985

JOB SPECIFICATION

NQ	NMN	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .10 .20 .30 .40 .50 1.00

****

SUB-AREA RUNOFF COMPUTATION

INFLOW RATES POND DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	6.31	0.00	7.88	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.33 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 84 END-OF-PERIOD ORDINATES, LAG= 2.34 HOURS, CP= .45 VOL= 1.00

34.	91.	187.	300.	425.	551.	658.	738.	789.	801.
769.	719.	671.	627.	586.	548.	512.	478.	447.	417.

198.	185.	173.	161.	151.	141.	132.	123.	115.	107.
100.	94.	88.	82.	76.	71.	67.	62.	58.	54.
51.	48.	44.	41.	39.	36.	34.	32.	30.	28.
26.	24.	23.	21.	20.	18.	17.	16.	15.	14.
13.	12.	11.	11.	10.	9.	9.	8.	8.	7.
7.	6.	6.	5.						

END-OF-PERIOD FLOW

	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
SUM											24.76	22.38	2.39	313997.
											(629.)	(568.)	(61.)	(8891.48)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THRU RAKES POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	8	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.00	0.00	1	1	0	0	8

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-495.	-1

STAGE	494.90	495.90	496.90	497.90	498.90	499.90	500.90
FLOW	0.00	354.00	990.00	1699.00	2600.00	3634.00	4776.00
SURFACE AREA=		0.	15.	126.			
CAPACITY=		0.	25.	331.			
ELEVATION=		490.	495.	500.			

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
494.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
498.6	0.0	0.0	0.

CREST LENGTH	0.	23.	205.	345.
AT OR BELOW ELEVATION	498.6	499.0	499.2	499.6

PEAK OUTFLOW IS 1072. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 2091. AT TIME 43.25 HOURS

PEAK OUTFLOW IS <8. AT TIME 43.25 HOURS

9-D

PEAK OUTFLOW IS 4296. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 5433. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 10891. AT TIME 42.75 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE RAKES OUTFLOW TO MARSHALL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

OLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

P-17

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0650	.0350	.0650	471.0	500.0	4800.	.00200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 508.00 200.00 480.00 410.00 475.00 415.00 471.00 420.00 471.00
425.00 475.00 510.00 500.00 610.00 500.00

STORAGE	0.00	1.16	2.97	6.45	22.29	53.28	99.55	153.82	212.13	278.29
	360.31	810.17	883.89	561.45	642.87	728.14	817.26	910.22	1007.84	1107.71
OUTFLOW	0.00	20.95	76.42	185.66	483.16	1140.49	2319.48	4254.71	6729.89	9727.41
	13245.95	17287.10	21856.89	26963.67	32617.29	38828.62	45689.22	52971.18	60926.86	69888.91
STAGE	471.00	472.53	474.05	475.58	477.11	478.63	480.16	481.68	483.21	484.74
	486.26	487.79	489.32	490.84	492.37	493.89	495.42	496.95	498.47	500.00
FLOW	0.00	20.95	76.42	185.66	483.16	1140.49	2319.48	4254.71	6729.89	9727.41
	13245.95	17287.10	21856.89	26963.67	32617.29	38828.62	45689.22	52971.18	60926.86	69888.91

MAXIMUM STAGE IS 478.4

MAXIMUM STAGE IS 479.8

MAXIMUM STAGE IS 488.8

MAXIMUM STAGE IS 481.7

MAXIMUM STAGE IS 482.4

MAXIMUM STAGE IS 485.2

********** *********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

PARTIALINFLOW TO MARSHALL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.57	0.00	1.88	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.17 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 43 END-OF-PERIOD ORDINATES, LAG= 1.18 HOURS, CP= .45 VOL= 1.00

33.	122.	240.	340.	382.	362.	317.	278.	244.	214.
187.	164.	144.	126.	111.	97.	85.	75.	65.	57.
50.	44.	39.	34.	30.	26.	23.	20.	18.	15.
13.	12.	10.	9.	8.	7.	6.	5.	5.	4.
4.	3.	3.							

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 24.76 22.38 2.39 88173.
(629.)(568.)(61.)(2496.78)

********** *********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE RAKES OUTFLOW & SUBAREA A2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	2	0	0	0	0	1	0	0

P-18

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THRU MARSHALL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-470.	-1

STAGE	470.20	470.60	471.30	472.10	472.80	473.60	474.30	475.00	475.70	476.40
	477.20	477.90	478.60							
FLOW	0.00	75.00	332.00	697.00	1145.00	1665.00	2250.00	2895.00	3597.00	4354.00
	5162.00	6021.00	6929.00							
SURFACE AREA=	0.	11.	70.							
CAPACITY=	0.	40.	395.							
ELEVATION=	459.	470.	488.							

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
470.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
471.8	0.0	0.0	0.

CREST LENGTH AT OR BELOW ELEVATION	0.	62.	125.	225.
	471.8	472.1	472.5	473.5

PEAK OUTFLOW IS 1266. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 2489. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 3758. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 5203. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 6662. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 13523. AT TIME 42.7[illegible] HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	1	6.31	1	1136.	2272.	3409.	4545.	5681.	11362.
		(16.34)		(32.17)(	64.35)(	96.52)(	128.70)(	160.87)(	321.75)(
ROUTED TO	2	6.31	1	1072.	2091.	3128.	4296.	5433.	10891.
		(16.34)		(30.36)(	59.20)(	88.57)(	121.64)(	153.84)(	308.40)(
ROUTED TO	3	6.31	1	1045.	2057.	3097.	4243.	5386.	10842.
		(16.34)		(29.60)(	58.25)(	87.69)(	120.15)(	152.51)(	307.02)(
HYDROGRAPH AT	4	1.57	1	409.	818.	1226.	1635.	2044.	4088.
		(4.07)		(11.58)(	23.15)(	34.73)(	46.30)(	57.88)(	115.76)(
2 COMBINED	5	7.88	1	1271.	2498.	3771.	5213.	6693.	13554.
		(20.41)		(36.00)(	70.74)(	106.77)(	147.62)(	189.52)(	383.81)(
ROUTED TO	6	7.88	1	1266.	2489.	3758.	5203.	6662.	13523.
		(20.41)		(35.34)(	70.49)(	106.41)(	147.34)(	188.64)(	382.94)(

SUMMARY OF DAM SAFETY ANALYSIS

RAKES DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	494.90	494.90	498.60
STORAGE	23.	23.	185.
OUTFLOW	0.	0.	2330.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	497.02	0.00	83.	1072.	0.00	43.00	0.00
.20	498.33	0.00	164.	2091.	0.00	43.25	0.00
.30	499.32	.72	253.	3128.	4.25	43.25	0.00
.40	499.91	1.31	320.	4296.	6.25	43.00	0.00
.50	500.34	1.74	375.	5433.	7.25	42.75	0.00
1.00	501.96	3.36	648.	10891.	9.25	42.75	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	1045.	478.4	43.50
.20	2057.	479.8	43.75
.30	3097.	480.8	43.50
.40	4243.	481.7	43.25
.50	5386.	482.4	43.25
1.00	10842.	485.2	43.00

12-0

SUMMARY OF DAM SAFETY ANALYSIS MARSHALL LAKE

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	470.20	470.20	471.80
STORAGE	40.	40.	62.
OUTFLOW	0.	0.	560.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	472.71	.91	80.	1266.	7.75	43.25	0.00
.20	473.59	1.79	100.	2489.	9.50	43.25	0.00
.30	474.21	2.41	117.	3758.	10.25	43.00	0.00
.40	474.82	3.02	136.	5203.	11.00	43.00	0.00
.50	475.37	3.57	155.	6662.	11.75	43.00	0.00
1.00	477.57	5.77	249.	13523.	15.00	42.75	0.00

D 22

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       NATIONAL DAM INSPECTION PROGRAM
    2                A2       BREACH ANALYSIS
    3                A3       MARSHALL LAKE DAM PA0985
    4                B     150        0       15        0        0        0        0        0       -4        0
    5                B1      5        0        0        0        0        0        0        0        0        0
    6                J       2        2        1        0        0        0        0        0        0        0
    7                J1     .2       .5        0        0        0        0        0        0        0        0
    8                K       0        1        0        0        0        0        1        0        0        0
    9                K1       INFLOW RAKES POND DAM
   10                M       1        1     6.31        0     7.88        0        0        0        1        0
   11                P       0     21.8      111      123      133      142        0        0        0        0
   12                T       0        0        0        0        0        0        1      .05        0        0
   13                U    2.33      .45        0        0        0        0        0        0        0        0
   14                X    -1.5     -.05        2        0        0        0        0        0        0        0
   15                K       1        2        0        0        0        0        1        0        0        0
   16                K1       ROUTE THRU RAKES POND
   17                Y       0        0        0        1        1        0        0        0        0        0
   18                Y1      1        0        0        0        0        0   -494.9       -1        0        0
   19                Y4  494.9    495.9    496.9    497.9    498.9    499.9    500.9        0        0        0
   20                Y5      0      354      990     1699     2600     3634     4776        0        0        0
   21                SA      0     14.7      126        0        0        0        0        0        0        0
   22                SE    490      495      500        0        0        0        0        0        0        0
   23                SS  494.9        0        0        0        0        0        0        0        0        0
   24                SD  498.6        0        0        0        0        0        0        0        0        0
   25                SL      0       23      205      345        0        0        0        0        0        0
   26                SV  498.6      499    499.2    499.6        0        0        0        0        0        0
   27                K       1        3        0        0        0        0        1        0        0        0
   28                K1       ROUTE RAKES OUTFLOW TO MARSHALL LAKE
   29                Y       0        0        0        1        1        0        0        0        0        0
   30                Y1      1        0        0        0        0        0        0        0        0        0
   31                Y6   .065     .035     .065      471      500     4800     .002        0        0        0
   32                Y7      0      500      200      480      410      475      415      471      420      471
   33                Y7    425      475      510      480      610      500        0        0        0        0
   34                K       0        4        0        0        0        0        1        0        0        0
   35                K1       PARTIAL INFLOW TO MARSHALL LAKE
   36                M       1        1     1.57        0     7.88        0        0        0        1        0
   37                P       0     21.8      111      123      133      142        0        0        0        0
   38                T       0        0        0        0        0        0        1      .05        0        0
   39                U    1.17      .45        0        0        0        0        0        0        0        0
   40                X    -1.5     -.05        2        0        0        0        0        0        0        0
   41                K       2        5        0        0        0        0        1        0        0        0
   42                K1       COMBINE RAKES OUTFLOW & SUBAREA A2
   43                K       1        6        0        0        0        0        1        0        0        0
   44                K1       ROUTE THRU MARSHALL LAKE
   45                Y       0        0        0        1        1        0        0        0        0        0
   46                Y1      1        0        0        0        0        0   -470.2       -1        0        0
   47                Y4  470.2    470.6    471.3    472.1    472.8    473.6    474.3    475.0    475.7    476.4
   48                Y4  477.2    477.9    478.6        0        0        0        0        0        0        0
   49                Y5      0       75      332      697     1145     1665     2250     2895     3597     4354
   50                Y5   5162     6021     6929        0        0        0        0        0        0        0
```

D-23

51	$A	0	11	70	0	0	0	0	0	0	0
52	$E	459.3	470.2	480	0	0	0	0	0	0	0
53	$$	470.2	0	0	0	0	0	0	0	0	0
54	$D	471.8	0	0	0	0	0	0	0	0	0
55	$L	0	62	125	225	0	0	0	0	0	0
56	$V	471.8	472.1	472.5	473.5	0	0	0	0	0	0
57	$B	20	1	462.9	.25	470.20	472.8	0	0	0	0
58	$B	40	1	462.9	.25	470.20	472.8	0	0	0	0
59	K	99	0	0	0	0	0	0	0	0	0

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE= 81/06/16.
TIME= 09.30.07.

NATIONAL DAM INSPECTION PROGRAM
BREACH ANALYSIS
MARSHALL LAKE DAM PA0985

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 2 LRTIO= 1

RTIOS= .20 .50

D+25

****

SUB-AREA RUNOFF COMPUTATION

INFLOW RAKES POND DAM

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	6.31	0.00	7.88	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.33 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 84 END-OF-PERIOD ORDINATES, LAG= 2.34 HOURS, CP= .45 VOL= 1.00

24.	51.	147.	300.	425.	551.	658.	738.	789.	801.
769.	719.	671.	627.	586.	548.	512.	478.	447.	417.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	278.	260.	242.	227.	212.

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE= 81/06/16.
TIME= 09.30.07.

NATIONAL DAM INSPECTION PROGRAM
BREACH ANALYSIS
MARSHALL LAKE DAM PA0985

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 2 LPTIO= 1

RTIOS= .20 .50

****

SUB-AREA RUNOFF COMPUTATION

INFLOW RAKES POND DAM

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	6.31	0.00	7.88	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.33 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 84 END-OF-PERIOD ORDINATES, LAG= 2.34 HOURS, CP= .45 VOL= 1.00

24.	91.	167.	300.	425.	551.	658.	738.	789.	801.
769.	719.	671.	627.	586.	548.	512.	478.	447.	417.

198.	185.	173.	161.	151.	141.	132.	123.	115.	107.
100.	94.	88.	82.	76.	71.	67.	62.	58.	54.
51.	48.	44.	41.	39.	36.	34.	32.	30.	28.
26.	24.	23.	21.	20.	18.	17.	16.	15.	14.
13.	12.	11.	11.	10.	9.	9.	8.	8.	7.
7.	6.	6.	5.						

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.76	22.38	2.39	313997.
										(629.)	(568.)	(61.)	(8891.48)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THRU RAKES POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JRGT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-495.	-1

STAGE	494.90	495.90	496.90	497.90	498.90	499.90	500.90
FLOW	0.00	354.00	990.00	1699.00	2600.00	3634.00	4776.00
SURFACE AREA=	0.	15.	126.				
CAPACITY=	0.	25.	331.				
ELEVATION=	490.	495.	500.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
494.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
498.6	0.0	0.0	0.

CREST LENGTH	0.	23.	205.	345.
AT OR BELOW ELEVATION	498.6	499.0	499.2	499.6

PEAK OUTFLOW IS 2001. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 5433. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 2091. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 5433. AT TIME 42.75 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE RAKES OUTFLOW TO MARSHALL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

MSTPS	MSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

B-28-0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0650	.0350	.0650	471.0	500.0	4800.	.00200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 500.00 200.00 480.00 410.00 475.00 415.00 471.00 420.00 471.00
425.00 475.00 510.00 480.00 610.00 500.00

STORAGE	0.00	1.16	2.97	6.45	22.29	53.28	99.35	153.82	212.13	274.29
	340.31	410.17	483.89	561.45	642.87	728.14	817.26	910.22	1007.04	1107.71
OUTFLOW	0.00	20.95	76.42	185.66	483.16	1140.49	2319.48	4254.71	6729.09	9727.91
	13245.95	17287.10	21856.89	26963.67	32617.29	38828.62	45609.22	52971.18	60926.86	69488.91
STAGE	471.00	472.53	474.05	475.58	477.11	478.63	480.16	481.68	483.21	484.79
	486.26	487.79	489.32	490.84	492.37	493.89	495.42	496.95	498.47	500.00
FLOW	0.00	20.95	76.42	185.66	483.16	1140.49	2319.48	4254.71	6729.09	9727.91
	13245.95	17287.10	21856.89	26963.67	32617.29	38828.62	45609.22	52971.18	60926.86	69488.91

MAXIMUM STAGE IS 479.8

MAXIMUM STAGE IS 482.4

MAXIMUM STAGE IS 479.8

MAXIMUM STAGE IS 482.4

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

PARTIALINFLOW TO MARSHALL LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.57	0.00	7.88	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.80	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.17 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 43 END-OF-PERIOD ORDINATES, LAG= 1.18 HOURS, CP= .45 VOL= 1.00

33.	122.	240.	340.	382.	362.	317.	278.	244.	214.
187.	164.	144.	126.	111.	97.	85.	75.	65.	57.
50.	44.	39.	34.	30.	26.	23.	20.	18.	15.
13.	12.	10.	9.	8.	7.	6.	5.	5.	4.
4.	3.	3.							

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.76	22.38	2.39	88173.
										(629.)	(568.)	(61.)	(2496.78)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE RAKES OUTFLOW & SUBAREA A2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

ROUTE THRU MARSHALL LAKE

ISTAQ	ICOMP	IFCON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	6

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-470.	-1

STAGE	470.20	470.60	471.30	472.10	472.80	473.60	474.30	475.00	475.70	476.00
	477.20	477.90	478.60							
FLOW	0.00	75.00	332.00	697.00	1145.00	1665.00	2250.00	2895.00	3597.00	4354.00
	5162.00	6021.00	6929.00							
SURFACE AREA=	0.	11.	70.							
CAPACITY=	0.	40.	395.							
ELEVATION=	459.	470.	480.							

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
470.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
471.8	0.0	0.0	0.

CREST LENGTH	0.	62.	125.	225.
AT OR BELOW ELEVATION	471.8	472.1	472.5	473.5

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
20.	1.00	462.90	.25	470.20	472.80

BEGIN DAM FAILURE AT 40.50 HOURS

PEAK OUTFLOW IS 3492. AT TIME 40.75 HOURS

BEGIN DAM FAILURE AT 38.50 HOURS

PEAK OUTFLOW IS 6665. AT TIME 42.75 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
40.	1.00	462.90	.25	470.20	472.80

BEGIN DAM FAILURE AT 40.50 HOURS

PEAK OUTFLOW IS 4684. AT TIME 40.75 HOURS

BEGIN DAM FAILURE AT 38.50 HOURS

PEAK OUTFLOW IS 6662. AT TIME 43.00 HOURS

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .50
HYDROGRAPH AT	1	6.31	1	2272.	5681.
		(16.34)		(64.35)(	160.87)(
			2	2272.	5681.
				(64.35)(	160.87)(
ROUTED TO	2	6.31	1	2091.	5433.
		(16.34)		(59.20)(	153.84)(
			2	2091.	5433.
				(59.20)(	153.84)(
ROUTED TO	3	6.31	1	2057.	5386.
		(16.34)		(58.25)(	152.51)(
			2	2057.	5386.
				(58.25)(	152.51)(
HYDROGRAPH AT	4	1.57	1	818.	2044.
		(4.07)		(23.15)(	57.88)(
			2	818.	2044.
				(23.15)(	57.88)(
2 COMBINED	5	7.88	1	2498.	6693.
		(20.41)		(70.74)(	189.52)(
			2	2498.	6693.
				(70.74)(	189.52)(
ROUTED TO	6	7.88	1	3492.	6665.
		(20.41)		(98.89)(	188.73)(
			2	4684.	6662.
				(132.63)(	188.65)(

SUMMARY OF DAM SAFETY ANALYSIS

RAKES DAM

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	494.90	494.98	498.60
STORAGE	23.	23.	185.
OUTFLOW	0.	0.	2330.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	498.33	0.00	164.	2091.	0.00	43.25	0.00
.50	500.34	1.74	375.	5433.	7.25	42.75	0.00

PLAN 2 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	494.90	494.98	498.60
STORAGE	23.	23.	185.
OUTFLOW	0.	0.	2330.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	498.33	0.00	164.	2091.	0.00	43.25	0.00
.50	500.34	1.74	375.	5433.	7.25	42.75	0.00

D193

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	2057.	479.8	43.75
.50	5386.	482.4	43.25

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	2057.	479.8	43.75
.50	5386.	482.4	43.25

SUMMARY OF DAM SAFETY ANALYSIS

MARSHALL LAKE

PLAN 1 ...20' WIDE BREACH

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	470.20	470.20	471.80
STORAGE	40.	40.	62.
OUTFLOW	0.	0.	560.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	472.94	1.14	85.	3492.	2.37	40.75	40.50
.50	474.18	2.38	117.	6665.	10.36	42.75	38.50

PLAN 2 ...40' WIDE BREACH

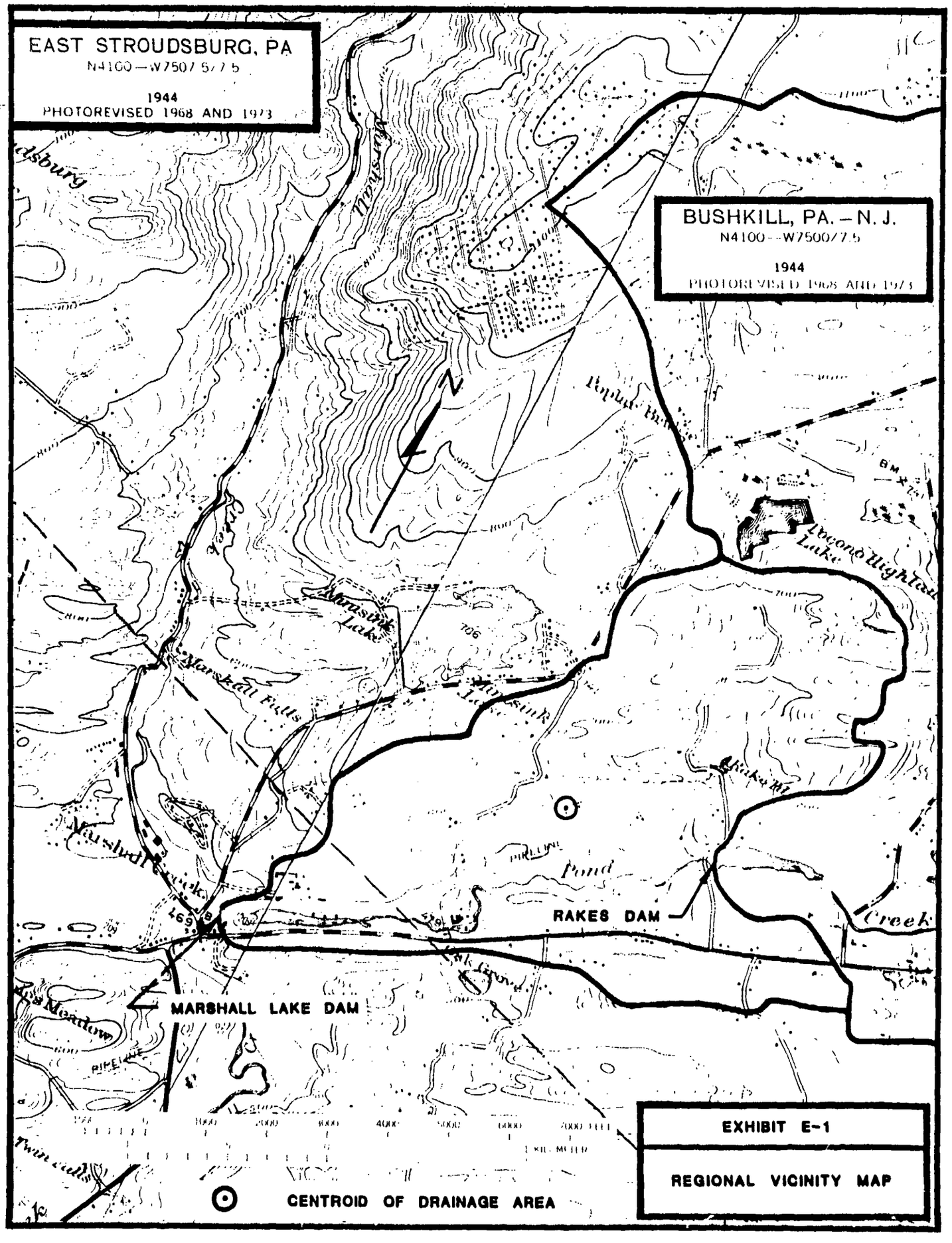
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	470.20	470.20	471.80
STORAGE	40.	40.	62.
OUTFLOW	0.	0.	560.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	472.93	1.13	85.	4684.	2.26	40.75	40.50
.50	473.27	1.47	92.	6662.	7.26	43.4.	38.50

D-84

APPENDIX E

EXHIBITS


EAST STROUDSBURG, PA
N4100—W7507 5/7 5
1944
PHOTOREVISED 1968 AND 1973
BUSHKILL, PA. – N. J.
N4100—W7500/7 5
1944
PHOTOREVISED 1968 AND 1973
Marshall Hills
Marshall Creek
Lake
Pond
RAKES DAM
MARSHALL LAKE DAM
PIPELINE
Twin Falls
CENTROID OF DRAINAGE AREA
EXHIBIT E-1
REGIONAL VICINITY MAP

LOOKING UPSTREAM TOWARD RIGHT ABUTMENT

SHOWING ICE HOUSE AND CHUTE

OUTLET CHANNEL, SHOWING RIPRAP BELOW WEIR

SPILLWAY

CONDITIONS ON MAY 8, 1919

EXHIBIT E-2

DOWNSTREAM SLOPE AT LEFT END

DAM

CONDITIONS ON MAY 8, 1919

EXHIBIT E-3

APPENDIX F

GEOLOGY

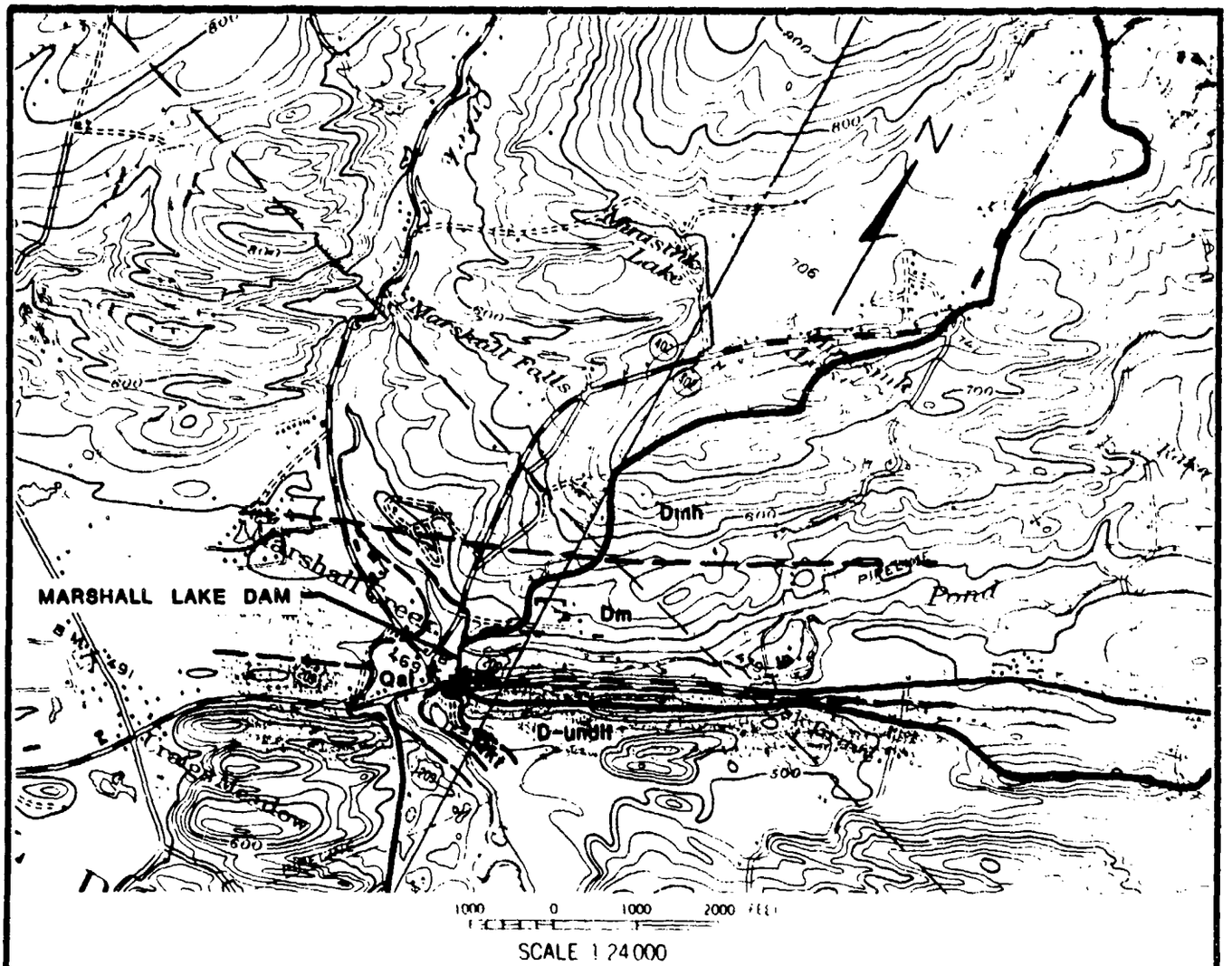
MARSHALL LAKE DAM
APPENDIX F
GEOLOGY

The Marshall Lake Dam lies within Monroe County and is part of the Pocono Plateau Section in the Appalachian Plateau Province. The principal bedrock unit is the Marcellus Formation of the Devonian Age. The soils underlying and surrounding the site consists of glacial deposits. The entire area lies within the Wisconsin and Moraine and is covered by a variety of glacial deposits.

The Marcellus Formation is a dark gray to black shale which underlies the broad valley of Marshalls Creek. One outcrop of the shale could be seen on the right abutment where the foundation of the old ice house was located. The rocks generally have a low to moderate dip and a regional N55^{O}E strike.

The glacial deposits are ice-contact stratified drift with the associated land forms such as kame terraces, etc. A kame terrace has been mapped downstream from the dam. This kame terrace is made up mostly of sand and gravels. Recent alluvial material is mapped along the streams that converge below the dam. Only a thin mantel of glacial material covers bedrock around and under the reservoir. This has been estimated to be less than three feet in thickness.

Bucek, Mikna F, "Surficial Geology of the East Stroudsburg 7½ Minute Quadrangle Monroe County, Pennsylvania". Pennsylvania Geologic Survey Harrisburg, Pa. 1981.



SCALE 1:24000

LEGEND

Dmh	MAHANTANGO FORMATION	BEDROCK
Dm	MARCELLUS FORMATION	BEDROCK
D-undif	DEVONIAN UNDIFFERENTIATED	BEDROCK
Qkt	KAME TERRACE, SAND GRAVEL	
Qal	ALLUVIUM	

NOTE:

GEOLOGIC MAP AND LEGEND OBTAINED FROM OPEN FILE MAP OF PENNSYLVANIA BY PA. TOPOGRAPHIC AND GEOLOGIC SURVEY, DATED 1980

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHALL LAKE DAM
GEOLOGIC MAP

GEO - Technical Services, Inc.
HARRISBURG, PA

JUNE, 1981

EXHIBIT F